SOME IMPORTANT DEFINITIONS

(n+l) Rule :- • The subshell / orbital having higher value of (n+l) will have higher energy.

• If two subshell have same value of n+l then the subshell having higher value of n will have higher energy.

Ex Arrange the following subshell in increasing order of energy 2s, 3p, 4s, 3d, 5p, 6s, 4f, 5d

SOME IMPORTANT DEFINITIONS

Subshell	2s	3p	4s	3d	5p	6s	4f	5d
n	2	3	4	3	5	6	4	5
l	0	1	0	2	1	0	3	2
$n+l$ =	2	4	4	5	6	6	7	7

$2s < 3p < 4s < 3d < 5p < 6s < 4f < 5d$.

Ex. Compare the energy of following orbitals

(i) $1s < 2s$

	1s	2s
n =	1	2
l =	0	0
$n+l$ =	1	2

SOME IMPORTANT DEFINITIONS

(2) $2p_x = 2p_y = 2p_z$

	$2p_x$	$2p_y$	$2p_z$
$n=$	2	2	2
$l=$	1	1	1
$n+l$	3	3	3

(3) $3d_{xy} = 3d_{yz} = 3d_{xz} = 3d_{z^2} = 3d_{x^2-y^2}$

	$3d_{xy}$	$3d_{yz}$	$3d_{xz}$	$3d_{z^2}$	$3d_{x^2-y^2}$
$n=$	3	3	3	3	3
$l=$	2	2	2	2	2

(4) $3p_x < 4d_{x^2-y^2}$

	$3p_x$	$4d_{x^2-y^2}$
$n=$	3	4
$l=$	1	2
	4	6

SOME IMPORTANT DEFINITIONS

Note :- 1 Degenerate orbitals :- The orbitals having same energy

Ex. $2p_x = 2p_y = 2p_z$, $3d_{xy} = 3d_{yz} = 3d_{zx} = 3d_{x^2-y^2} = 3d_{z^2}$

$3p_x = 3p_z = 3p_z$

2

Bohr :- Bohr gave his rule for unielectron species.

*** { H, He^+, Li^{+2}, Be^{+3}, B^{+4}, ... Na^{+10} $\Rightarrow$ ${}_{Z}A^{+(Z-1)}$

$1s < 2s = 2p < 3s = 3p = 3d < 4s = 4p = 4d = 4f < \ldots\ldots$

Ex. pick out correct order of energy for Li^{+2}

(a) 1s < 2s (b) 2s = 2p (c) 3s < 3p < 3d

n = 1 2 n = 2 2

Ex. find the subshell represented by $n + l = 5$ and arrange them in increasing order of energy for multielectron species.

$n + l = 5$

$5 + 0 \rightarrow 5s$

$4 + 1 \rightarrow 4p$

$3 + 2 \rightarrow 3d$

× $2 + 3$

3d < 4p < 5s

Ex. find the subshell represented by $n+l=7$ and arrange then in increasing order of energy for multielectron species.

$$n+l = 7$$

$7+0 = 7s$

$6+1 = 6p$

$5+2 = 5d$

$4+3 = 4f$

× $3+4$

$$4f < 5d < 6p < 7s$$

SOME IMPORTANT DEFINITIONS

HW

Ex. find the subshell represented by $2 < n+l \leq 8$ and arrange then in increasing order of energy for multielectron species.

$n+l = 3$

$n+l = 4$

$n+l = 5$

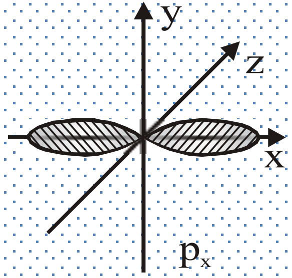
QUANTUM NUMBERS

Orientation of orbitals:

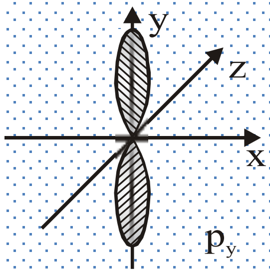
's' → Direction less

'p' →

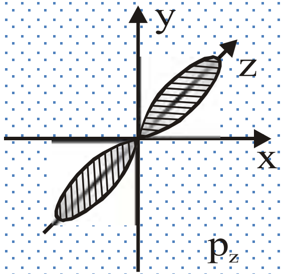
(a) p_x



(b) p_y

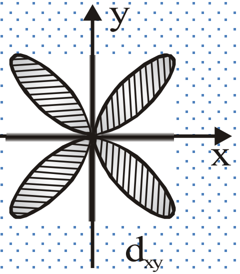


(c) p_z

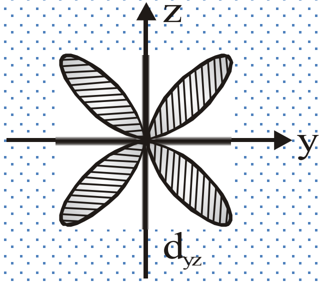


'd' $\rightarrow$

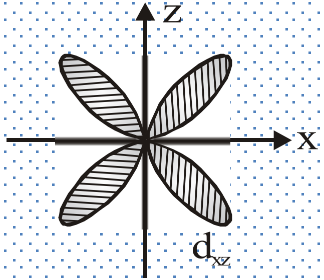
(a) d_{xy}



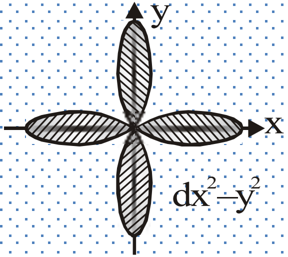
(b) d_{yz}



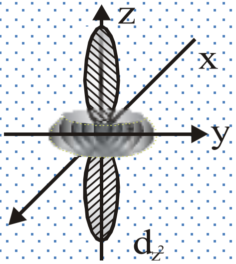
(c) d_{xz}



(d) $d_{x^2-y^2}$



(e) d_{z^2}



Note : No. of orbital in a shell = n^2

SOME IMPORTANT DEFINITIONS

QUANTUM NUMBERS

Q.1 Determine the orbitals from the following value of n, l, m

	n	ℓ	m	orbital
(a)	2	1	–1	$2p_x$ or $2p_y$
(b)	4	0	0	4s
(c)	5	2	+1	$5d_{yz}$ ~~/ $5d_{xz}$~~
(d)	3	1	0	$3p_z$
(e)	Ψ_{420}			$4d_{z^2}$

$\psi_{n,\ell,m}$

$\psi_{3,2,0}$

$\hookrightarrow 3d_{z^2}$

$\psi_{3,0,0}$

3s

$\psi_{3,2,1}$

$m=0$ $\rightarrow$ p $\rightarrow$ p_z

$\rightarrow$ d $\rightarrow$ d_{z^2}

QUANTUM NUMBERS

Q.2 Find out the value of n, ℓ, m, for the following orbitals

(A) $4d_{z^2}$: n = 4, ℓ = 2, m = 0

(B) 5s : n = 5, ℓ = 0, m = 0

(C) $3p_z$: n = 3, ℓ = 1, m = 0

(D) $2p_x$: n = 2, ℓ = 1, m = 1

QUANTUM NUMBERS

Q.3 Identify the orbitals for the following values of n, ℓ, m

Orbital	n	ℓ	m
$4p_y$	4	1	–1
$3d_{z^2}$	3	2	0
3s	3	0	0
3d	3	2	2
$4d_{z^2}$	$\Psi_{4,20}$		

QUANTUM NUMBERS

Q.4 Which of the following set of Quantum no. is possible.

(A) $n = 3, \ell = 2, m = -3, s = +\frac{1}{2}$

(B) $n = 3, \ell = 3, m = 0, s = -\frac{1}{2}$

(C) $n = 3, \ell = 1, m = -1, s = -\frac{1}{2}$

(D) $n = 4, \ell = 2, m = 0, s = +1$

QUANTUM NUMBERS

Q.5 Calculate the total number of electron in d Subshell.

(A) 1 (B) 2

(C) 10 (D)

None of these

Sol. 'd' subshell $\Rightarrow \ell = 2$

No of $e^- = 2(2\ell + 1)$

$= 2(5)$

$= 10$

QUANTUM NUMBERS

Q.6 In orbitals of $n = 3$, $\ell = 2$ find out total number of electrons for which the value of spin Quantum no. is $\frac{-1}{2}$

(A) 1 (B) 5

(C) 10 (D) None of these

Sol. $n = 3$, $\ell = 2$

$\Rightarrow$ 3d subshell

$$\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}$$

e^- with $\left(s = \frac{-1}{2}\right) = 5$

QUANTUM NUMBERS

Q.7 For $n + \ell = 5$, find out total number of sub shells, total no. of orbitals, total no. of electrons.

Sol. $n + \ell = 5$

$n = 1$; not possible

$n = 2$; not possible

$n = 3$; $\ell = 2$('d' subshell)

One subshell, 5 orbital, $10e^-$

$n = 4$, $\ell = 1$ ('p' subshell)

One subshell, 3 orbital, $6e^-$

$n = 5$, $\ell = 0$, ('s' subshell)

One subshell, 1 orbital, $2e^-$

no of subshell = 3

no of orbitals = 9

no of e^- = 18

QUANTUM NUMBERS

Q.8 Which of the following is not permissible arrangement of electron in an atom.

(A) n = 3, ℓ = 2, m = 2, s = $-\frac{1}{2}$

(B) n = 4, ℓ = 0, m = 0, s = $-\frac{1}{2}$

(C) n = 5, ℓ = 3, m = 0, s = $+\frac{1}{2}$

(D) n = 4, ℓ = 2, m = 3, s = $+\frac{1}{2}$

QUANTUM NUMBERS

Q.9 Total no. of atomic orbitals in 4^{th} energy level will be

(A) 8

(B) 16

(C) 32

(D) 4

Sol. No of orbital $= n^2$

$= (4)^2 = 16$

QUANTUM NUMBERS

Q.10 Pick out the correct sequence of quantum number in the followings :-

(1) $n = 3, \ell = 2, m = 3, s = -\frac{1}{2}$

(2) $n = 2, \ell = 2, m = 1, s = +\frac{1}{2}$

(3) $n = 3, \ell = 1, m = -1, s = -\frac{1}{2}$

(4) $n = 2, \ell = 1, m = 0, s = +1$

QUANTUM NUMBERS

Q.11 Calculate no. of electrons which have following quantum number

$n = 3, \ell = 2, m = +1, s = -\frac{1}{2}$

QUANTUM NUMBERS

Node:

It is point/line/plane/surface where probability of finding electron is zero.

There are 2 types of node :

(1) Radial node/Spherical node/Nodal surface = $n - \ell - 1$

(2) Angular node/Non-spherical node/Nodal plane = ℓ

Total node = Radial node + Angular node

$= n - \ell - 1 + \ell$

Total node = $n - 1$

Subshell	Radial node ($n - \ell - 1$)	Nodal plane (ℓ)	Total node ($n - 1$)
1s	0	0	0
2s	1	0	1
3s	2	0	2
2p	0	1	1
3p	1	1	2
3d	0	2	2
4d	1	2	3

QUANTUM NUMBERS

Type of Nodal plane :

s	–
p_x	yz
p_y	xz
p_z	xy
d_{xy}	yz & zx
d_{yz}	xz & xy
d_{yz}	xy & yz
$d_{x^2-y^2}$	2 (at 45°)
d_{z^2}	0 (nodal plane)

Special Ex. $3d_{z^2}$ = 0 node

$4d_{z^2}$ = 1 (nodal surface)

$5d_{z^2}$ = 2 (nodal surface)

SOME IMPORTANT DEFINITIONS

Ex. find max. no of electrons possible in Subshell, s, p, d, f. ?

Subshell	l	orbitals $(2l+1)$	electrons $(4l+2)$
s	0	1	2
p	1	3	6
d	2	5	10
f	3	7	14

Electronic Configuration

- Electronic configuration is filling of electron in orbitals of an atom.

$n l^x$

x → no of electrons.

l → Subshell

n → Shell

It is determined by following rules.

(1) Auffbau principal

(2) Pauli exclusion principle

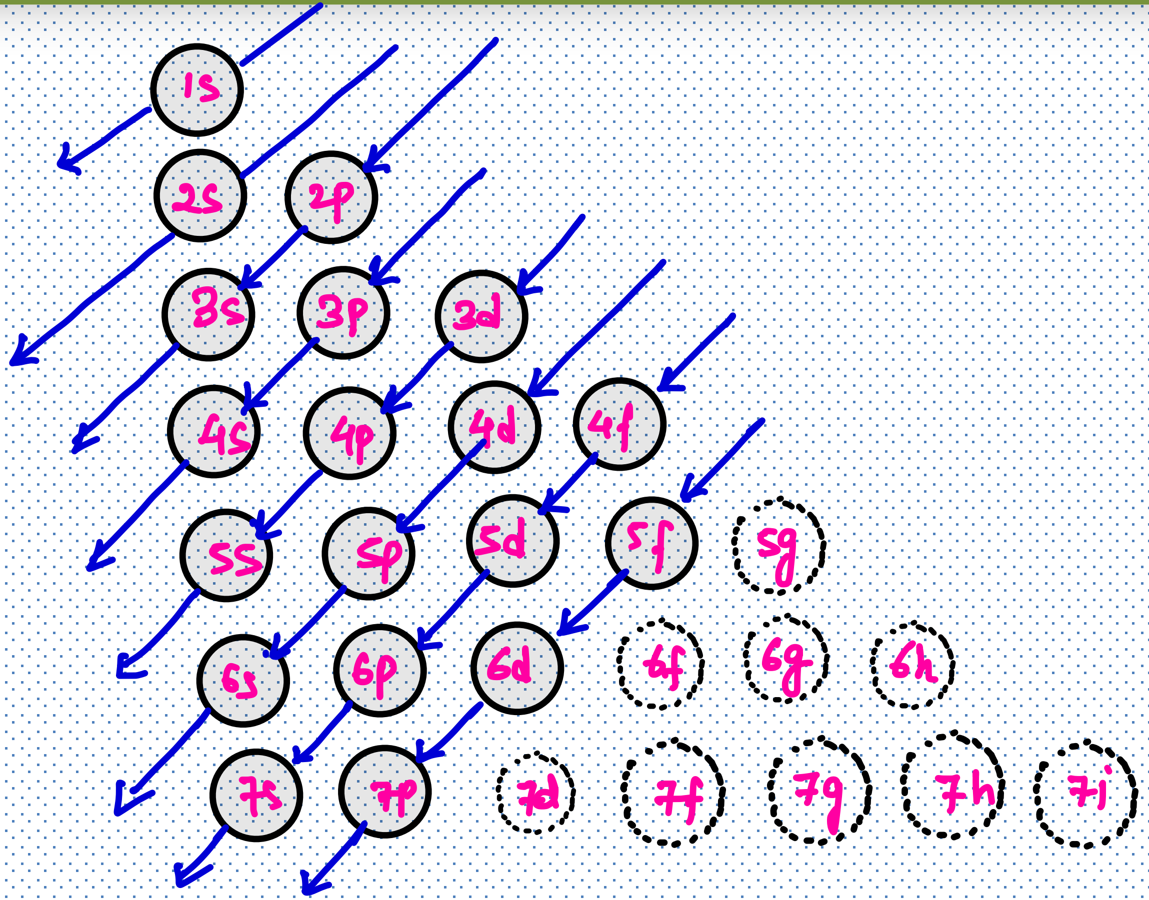
(3) Hunds Rule of maximum multiplicity.

SOME IMPORTANT DEFINITIONS

Aufbau principle ÷ Aufbau is a German word which means buiding up.

- (n+l) rule.
- Filling of electron take place in increasing of energy of orbitals.

SOME IMPORTANT DEFINITIONS



SOME IMPORTANT DEFINITIONS

[H] $Z=1$, $e=1$ = $1s^1$

[He], $Z=2$ ⇒ $1s^2$

[Li] $1s^2, 2s^1$ OR [He], $2s^1$

[Be], $1s^2, 2s^2$

[B], $1s^2, 2s^2, 2p^1$

[C], $1s^2, 2s^2, 2p^2$

$Z=7$
$e=7$

[N], $1s^2, 2s^2, 2p^3$

[O], $1s^2, 2s^2, 2p^4$

[F], $1s^2, 2s^2, 2p^5$

[Ne], $1s^2, 2s^2, 2p^6$,

SOME IMPORTANT DEFINITIONS

[Na] (11) → $1s^2, 2s^2, 2p^6, 3s^1$ OR [Ne], $3s^1$

[Mg] . (12)

[Al]

[Si]

[P]

[S]

[Cl]

[Ar]

SOME IMPORTANT DEFINITIONS

K (19) = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$ OR $[Ar], 4s^1$

Ca (20) = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2$, OR $[Ar], 4s^2$

Exception

(i) $(n-1)d^4, ns^2$ → $(n-1)d^5, ns^1$

(ii) $(n-1)d^9, ns^2$ → $(n-1)d^{10}, ns^1$

iii) $(n-2)f^8\ (n-1)d^0, ns^2$ → $(n-2)f^7, (n-1)d^1, ns^2$

SOME IMPORTANT DEFINITIONS

Cr (24)

$\hookrightarrow 1s^2, 2s^2, \cancel{2p^6, 3s^2}, 3p^6, \underset{\times}{\underline{3d^4, 4s^2}}$

$= 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$

Cu (29)

$\hookrightarrow 1s^2, 2s^2, 2p^6, \cancel{3s^2}, 3p^6, 3d^9, 4s^2$

$\Downarrow$

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

SOME IMPORTANT DEFINITIONS

If electrons are removed then they are removed from last shell.

Mn^{+2}

$Mn(25) = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^2$

$Mn^{+2} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^0$

Cr^{+3}

$Cr(24) = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$

$Cr^{+3} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^3, 4s^0$

SOME IMPORTANT DEFINITIONS

Pauli exclusion principle

• In an atom no two electron can have same value of all four quantum No.

$\boxed{\uparrow\downarrow}$

3s

1st e^-	2nd e^-
$n = 3$	$n = 3$
$l = 0$	$l = 0$
$m = 0$	$m = 0$
$s = +\frac{1}{2}$	$s = -\frac{1}{2}$
✓	

⇒ "In an orbital max. of electron can be accomodated are two with opposit spin"

SOME IMPORTANT DEFINITIONS

- **Hund's maximum multiplicity**

- Multiplicity → "many of same kind"
- this rule is applicable for degenerate orbital.

E

H = $\boxed{\uparrow}$ $1s^1$

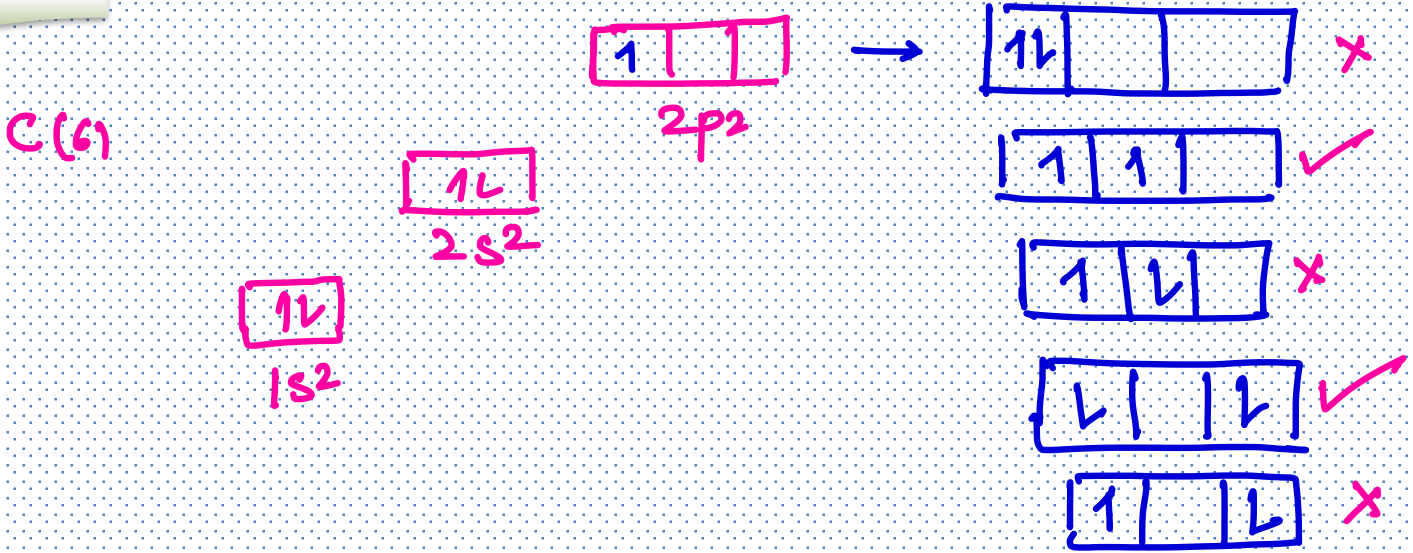
He $\boxed{\uparrow\downarrow}$ $1s^2$

(Li) $\boxed{\uparrow\downarrow}$ $1s^2$ $\boxed{\uparrow}$ $2s^1$

, Be $\boxed{\uparrow\downarrow}$ $1s^2$ $\boxed{\uparrow\downarrow}$ $2s^2$

B(5) $\boxed{\uparrow\downarrow}$ $1s^2$ $\boxed{\uparrow\downarrow}$ $2s^2$ $\boxed{\uparrow}\boxed{\ }\boxed{\ }$ $2p^1$

SOME IMPORTANT DEFINITIONS



Hund's Rule :- in a degenerate orbital pairing of e^- does not take place untill each degenerate orbital gets filled with single e^- of same spin

Mole Concept

SOME IMPORTANT DEFINITIONS

N (7)

$1s^2$ $\boxed{\uparrow\downarrow}$

$2s^2$ $\boxed{\uparrow\downarrow}$

$2p^3$ $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$ → unpaired $e^- = 3$

O (8)

$1s^2$ $\boxed{\uparrow\downarrow}$

$2s^2$ $\boxed{\uparrow\downarrow}$

$2p^4$ $\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}$ unpaired $e^- = 2$

SOME IMPORTANT DEFINITIONS

HW 1 – 30 write electronic configuration and tell no of unpaired e^-.

magnetic moment $(\mu) = \sqrt{n(n+2)}$ B.M.

find out magnetic moment of each Element and their possible ion.

7043 63 8933

SKT sir

RULES FOR FILLING OF ELECTRONS

(a) Aufbau Principle

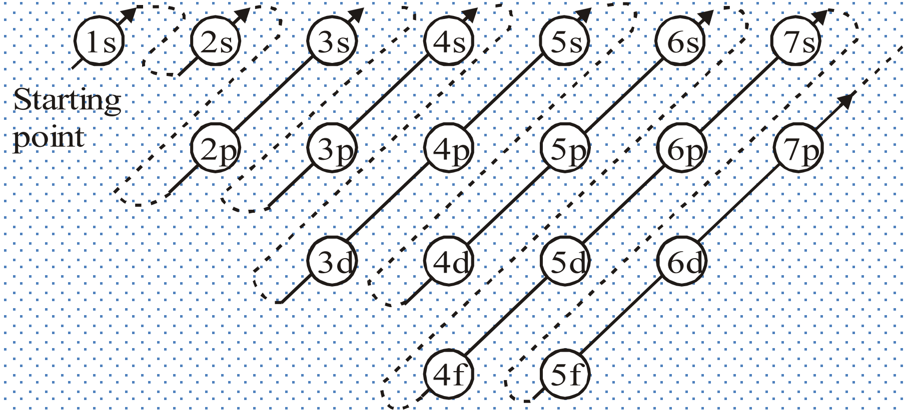
Aufbau is a German word and its meaning ' Building up'

- Aufbau principle gives a sequence in which various subshell are filled up depending on the relative order of the Energies of various subshell.

- Principle : The subshell with minimum energy is filled up first when this subshell obtained maximum quota of electrons then the next subshell of higher energy starts filling.

RULES FOR FILLING OF ELECTRONS

- The sequence in which various subshell are filled are as follows.



$1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^6$, $4s^2$, $3d^{10}$, $4p^6$, $5s^2$, $4d^{10}$, $5p^6$, $6s^2$, $4f^{14}$, $5d^{10}$, $6p^6$,$7s^2$, $5f^{14}$, $6d^{10}$, ...

RULES FOR FILLING OF ELECTRONS

For Example

$_{1}H$	$\rightarrow$	$1s^1$
$_{2}He$	$\rightarrow$	$1s^2$
$_{3}Li$	$\rightarrow$	$1s^2$, $2s^1$
$_{4}Be$	$\rightarrow$	$1s^2$, $2s^2$
$_{5}B$	$\rightarrow$	$1s^2$, $2s^2$, $2p^1$
$_{6}C$	$\rightarrow$	$1s^2$, $2s^2$,$2p^2$
$_{7}N$	$\rightarrow$	$1s^2$, $2s^2$, $2p^3$
$_{8}O$	$\rightarrow$	$1s^2$, $2s^2$, $2p^4$
$_{9}F$	$\rightarrow$	$1s^2$, $2s^2$, $2p^5$
$_{10}Ne$	$\rightarrow$	$1s^2$, $2s^2$, $2p^6$
$_{11}Na$	$\rightarrow$	$1s^2$, $2s^2$, $2p^6$, $3s^1$
$_{12}Mg$	$\rightarrow$	$1s^2$, $2s^2$, $2p^6$, $3s^2$
$_{13}Al$	$\rightarrow$	$1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^1$
$_{14}Si$	$\rightarrow$	$1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^2$
$_{15}p$	$\rightarrow$	$1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^3$

RULES FOR FILLING OF ELECTRONS

$_{16}S$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^4$
$_{17}Cl$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^5$
$_{18}Ar$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6$
$_{19}K$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$
$_{20}Ca$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2$
$_{21}Sc$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^1$
$_{22}Ti$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^2$
$_{23}V$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^3$
$_{24}Cr$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^5$ [Exception]
$_{25}Mn$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^5$
$_{26}Fe$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^6$
$_{27}Co$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^7$
$_{28}Ni$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^8$
$_{29}Cu$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^{10}$ [Exception]
$_{30}Zn$	$\rightarrow$	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}$

RULES FOR FILLING OF ELECTRONS

Electronic configuration can be written by following different methods :

- $_{26}Fe \rightarrow$ (1) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^6$

  (2) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^6, 4s^2$

  (3) $1s^2, 2s^2p^6, 3s^2p^6d^6, 4s^2$

  2 8 14 2

  (4) [Ar] $4s^2$ $3d^6$

- $_{26}Fe \rightarrow 1s^2\ \underbrace{2s^2 2p^6}_{(n-2)}\ \underbrace{3s^2 3p^6 3d^6}_{(n-1)}\ \underbrace{4s^2}_{n}$

  n $\rightarrow$ Outer most Shell or Ultimate Shell or Valence Shell

  In this Shell e^- are Called as Valance electron or this is called core charge

  (n–1) $\rightarrow$ Penultimate Shell or core or pre valence Shell

  (n–2) $\rightarrow$ Pre Penultimate Shell

RULES FOR FILLING OF ELECTRONS

- If we remove the last n Shell (ultimate Shell) then the remaining shells are collectively called as Kernel.

Ex. $_{26}Fe \rightarrow \underbrace{1s^2 2s^2 2p^6 3s^2 3d^6 3p^6}_{\text{Kernel}} 4s^2$

(b) (n + ℓ) Rule (For multi electron species)

According to it the sequence in which various subshell are filled up can also be determined with the help of (n +ℓ) value for a given subshell.

Principle of (n + ℓ) rule :

The subshell with lowest (n+ℓ) value is filled up first, When two or more subshell have same (n+ℓ) value then the subshell with lowest value of n is filled up first.

RULES FOR FILLING OF ELECTRONS

In case of H-atom :

Energy only depends on principle quantum number

$1s < 2s = 2p < 3s = 3p = 3d < 4s = 4p = 4d = 4f < ....$

Sub Shell	n	ℓ	$n + \ell$	
1s	1	0	1	
2s	2	0	2	
2p	2	1	3	(1)
3s	3	0	3	(2)
3p	3	1	4	(1)
4s	4	0	4	(2)
3d	3	2	5	(1)
4p	4	1	5	(2)
5s	5	0	5	(3)
4d	4	2	6	(1)
5p	5	1	6	(2)
6s	6	0	6	(3)

Order : $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^6, 5s^2, 4d^{10}, 5p^6, 6s^2, 4f^{14}, 5d^{10}, 6p^6, 7s^2, 5f^{14}, 6d^{10}, ...$

RULES FOR FILLING OF ELECTRONS

(c) **Hund's Maximum Multiplicity Rule** (Multiplicity : Many of the same kind)

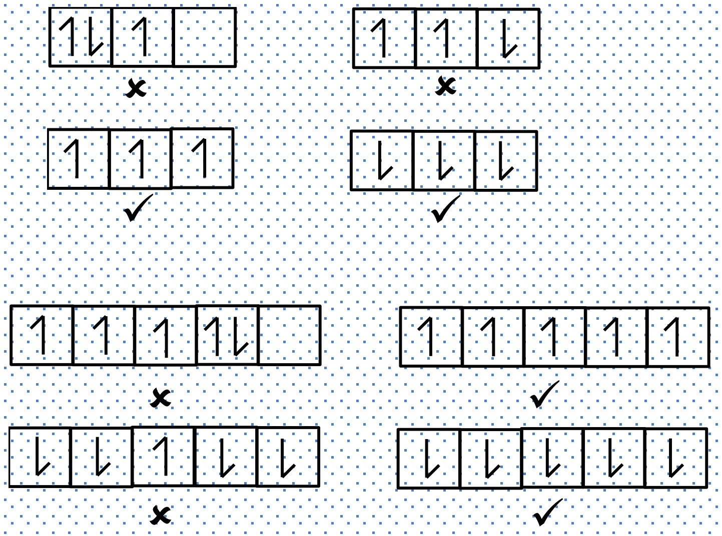
- According to Hund's rule electrons are distributed among the Orbitals of subshell in such a way as to give maximum number of unpaired electron with parallel spin.

- Thus the Orbital available in the subshell are first filled singly with parallel spin electron before they begin to pair this means that pairing of electrons occurs with the introduction of second electron in 's' subshell, fourth electron in 'p' subshell, 6^{th} electron in 'd' Subshell & 8^{th} e^{-} in 'f' subshell.

RULES FOR FILLING OF ELECTRONS

Ex. p^3

d^5



RULES FOR FILLING OF ELECTRONS

(d) Pauli's Exclusion Principle

In 1925 Pauli stated that no two electron in an atom can have same values of all four quantum numbers.

i.e., An orbital can accomodates maximum 2 electrons with opposite spin.

Ex.1. $_6C^{12} \rightarrow$

	$1s^2$	$2s^2$	$2p^2$
	$\boxed{\uparrow\downarrow}$	$\boxed{\uparrow\downarrow}$	$\boxed{\uparrow}\boxed{\uparrow}\boxed{}$ p_x p_z p_y
n	1	2	2
ℓ	0	0	1
m	0	0	+1, 0, −1
s	$+\frac{1}{2}, -\frac{1}{2}$	$+\frac{1}{2}, -\frac{1}{2}$	$+\frac{1}{2}, +\frac{1}{2}$

RULES FOR FILLING OF ELECTRONS

Ex.2 $_{17}Cl \rightarrow 1s^2 \; 2s^2 \; 2p^6 3s^2 \; 3P^5$

	$1s^2$	$2s^2$	$2p^6$	$3s^2$	$3P^5$
	$\boxed{\uparrow\downarrow}$	$\boxed{\uparrow\downarrow}$	$\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}$	$\boxed{\uparrow\downarrow}$	$\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow}$
n =	1	2	2	3	3
ℓ =	0	0	1	0	1
m =	0	0	+1, –1, 0	0	+1, –1, 0
	$+\frac{1}{2}, -\frac{1}{2}$	$+\frac{1}{2}, -\frac{1}{2}$	$+\frac{1}{2}, -\frac{1}{2}$ $+\frac{1}{2}, -\frac{1}{2}$ $+\frac{1}{2}, -\frac{1}{2}$	$+\frac{1}{2}, -\frac{1}{2}$	$+\frac{1}{2}, -\frac{1}{2}, +\frac{1}{2}, -\frac{1}{2}, +\frac{1}{2}$

RULES FOR FILLING OF ELECTRONS

Q.1 In the following configurations, determine which rule is violated ?

(a) $\underset{1s}{\boxed{\uparrow}}\ \underset{2s}{\boxed{\uparrow\uparrow}}\ \underset{2p}{\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}}$ (n + ℓ) rule (Aufbau)

(b) $\underset{1s}{\boxed{\uparrow}}\ \underset{2s}{\boxed{\uparrow\downarrow}}\ \underset{2p}{\boxed{\uparrow}\boxed{\downarrow}\boxed{\uparrow}}$ (n + ℓ) rule, Hund's rule

(c) $\underset{1s}{\boxed{\uparrow\downarrow}}\ \underset{2s}{\boxed{\uparrow\downarrow\uparrow}}\ \underset{2p}{\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{}}$ Hund's, Pauli's rule

RULES FOR FILLING OF ELECTRONS

Q.2 An atom has 2K, 8L, 5M electrons, then write it's electron configuration & calculate :-

(1) Number of subshell

(2) Number of orbitals

(3) Number of unpaired electrons

(4) Number of electron having $\ell = 1$

Sol.

2K	8L	5M
$\Downarrow$	$\Downarrow$	$\Downarrow$
n=1	n=2	n=3
$(2e^-)$	$(8e^-)$	$(3e^-)$

RULES FOR FILLING OF ELECTRONS

Configuration will be :-

$1s^2$	$2s^2$	$2p^6$	$3s^2$	$3p^3$
↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓	↑ ↑ ↑

no of subshell = 5

no of orbitals = 9

no of unpaired e^- = 3

no of having ℓ = 1('p' subshell) = 6 + 3 = 9

RULES FOR FILLING OF ELECTRONS

Q.3 For Cr atom, calculate the following :-

(1) Number of electron with $(m = 0)$

(2) Number of electron with $(\ell = 1, s = \frac{1}{2})$

(3) Number of electron with $(n = 3, m = -2)$

(4) Set of four quantum numbers for the last electron filled

RULES FOR FILLING OF ELECTRONS

Sol. $Cr \rightarrow$

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

(i)

$m = 0$

All 's' orbital | 1 orbital of 'p' | 1 orbital of 'd'

No. of e^- = $(2+2+2+1)$ | $(2+2)$ | (1)

No. of e^- = $7+4+1$

$= 12e^-$

RULES FOR FILLING OF ELECTRONS

(ii) $\ell = 1 \Rightarrow$ p subshell

'p' subshell have = 6 + 6 = 12e^-

but with $s = \frac{1}{2}$ = only 6e^-

(iii) n = 3, m = –2

3d subshell and any one orbital of 'd'

no. of e^- = 1

(iv) Last e^- in 3d

$n = 3, \ \ell = 2$

m = –2 to +2 (any integer value)

$s = -\frac{1}{2}$ or $+\frac{1}{2}$

RULES FOR FILLING OF ELECTRONS

Exception of Aufbau principle :

In some cases it is seen that the electronic configuration is slightly different from the arrangement given by Aufbau principle. A simple region behind this is that half filled & full filled subshell have got extra stability.

Ex.1 $_{24}Cr \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^4$

$4s$: $\boxed{\uparrow\downarrow}$ $3d$: $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{}$

(wrong configuration)

$_{24}Cr \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$

$4s$: $\boxed{\uparrow}$ $3d$: $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$

(right configuration)

RULES FOR FILLING OF ELECTRONS

Ex.2 $_{29}Cu \rightarrow \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^6 \quad 4s^2 \quad 3d^9$

(wrong configuration) $\quad \boxed{\uparrow\downarrow} \quad \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow}$

$_{24}Cr \rightarrow \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^6 \quad 4s^1 \quad 3d^{10}$

(right configuration) $\quad \boxed{\uparrow} \quad \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}$

Reason: Half filled and full filled subshells are more stable.
(due to exchange energy)

RULES FOR FILLING OF ELECTRONS

Some Special Point

1. Total spin $= \pm\frac{1}{2}$ (no. of unpaired e^-)

2. Magnetic moment (m) $= \sqrt{n(n+2)}$ B.M.
   Where 'n' is no. of unpaired electron.

3. Paramagnetic: Those species which contain one or more than one unpaired electron.

4. Dimagnetic: Those species which do not contain any unpaired electron.

RULES FOR FILLING OF ELECTRONS

5. Configuration of ion :

(a) First we have to write the configuration of atom in its ground state.

(b) Now, based upon the charge present on the atom we have to remove or add electrons in its valence shell

Na^+ :

(a) $Na \rightarrow 1s^2, 2s^2 2p^6, 3s^1$

(b) $Na^+ \rightarrow 1s^2, 2s^2 2p^6$

RULES FOR FILLING OF ELECTRONS

Cr^{+} :

(a) $Cr \rightarrow 1s^2, 2s^2 2p^6, 3s^2 3p^6, 4s^1, 3d^5$

↓

Valence

shell

(b) $Cr^{+} \rightarrow 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5$

$Cr^{+2} \rightarrow 1s^2, 2s^2 2p^6 3s^2 3p^6 3d^4$

$Cr^{+3} \rightarrow 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^3$

Fe^{+2} :

$Fe \rightarrow 1s^2, 2s^2 2p^6, 3s^2 3p^6 4s^2 3d^6$

$Fe^{+2} \rightarrow 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6$