

Chemistry Study Materials for Class 11 (NCERT Based Notes of Chapter- 02)

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Structure of Atom

Rules for Filling of electrons in various orbitals

The filling of electrons into the orbitals of different atoms takes place according to the 3 rules - Aufbau principle, Pauli's exclusion principle and the Hund's rule of maximum multiplicity.

1. Aufbau principle / $(n + l)^{\text{th}}$ rule:

The German word aufbau means 'build up'. The building up of orbitals means the filling up of orbitals with electrons. It states that ***the orbitals are filled in order of their increasing energies***. In other words, electrons first occupy the lowest energy orbital and then to higher energy orbitals.

This rule has two sub rules:

- a) The various sub-shells are filled in the increasing order of their $(n + l)$ value.
- b) If two sub-shells have the same $(n + l)$ values, the sub-shell with the lower n value is filled first.

$(n)^{\text{th}}$ value	$(l)^{\text{th}}$ value	$(n + l)^{\text{th}}$ value	sub-shells
1	0	1	1s
2	0	2	2s
	1	3	2p
3	0	3	3s
	1	4	3p
	2	5	3d
4	0	4	4s
	1	5	4p
	2	6	4d
	3	7	4f
5	0	5	5s
	1	6	5p
	2	7	5d
	3	8	5f
	4	9	-

The increasing order of sub-shells is as follows:

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p, 8s

Important Points

The filling of e^- in sub-shells follows this order. (As per Aufbau principle)

(i) $1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p < 6s < 4f < 5d < 6p < 7s < 5f < 6d < 7p$

(ii) Half filled and completely filled sub-shells have more **stability** than incompletely filled sub-shells. For atoms having half filled or completely filled electronic configurations have extra stability compared to other atoms. This is due to their symmetrical distribution of electrons and greater exchange energy.

(24) Cr = [Ar] $4s^2 3d^4$ changes to Cr = [Ar] $4s^1 3d^5$

(29) Cu = [Ar] $4s^2 3d^9$ changes to Cu = [Ar] $4s^1 3d^{10}$

For example, the electronic configuration of Cr is [Ar] $3d^5 4s^1$ and not $3d^4 4s^2$. This is because d^5 represents a half filled configuration and has extra stability. Similarly for Cu the electronic configuration is [Ar] $3d^{10} 4s^1$ and not $3d^9 4s^2$.

Electronic configuration

${}_{20}\text{Ca} - 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 / [\text{Ar}] 4s^2$

${}_{35}\text{Br} - 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5 / [\text{Ar}] 4s^2 3d^{10} 4p^5$

${}_{30}\text{Zn} - 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} / [\text{Ar}] 4s^2 3d^{10}$

(iii) Before the filling of electrons in f-sub-shell, if you have 1 to 14 electron(s) then at first one electron enters in next d- sub-shell and rest electron(s) fill up in f-sub-shell,

${}_{57}\text{La} - [\text{Xe}] 4f^1 5d^0$ changes to $[\text{Xe}] 4f^0 5d^1$ i.e. $[\text{Xe}] 5d^1$

${}_{58}\text{Ce} - [\text{Xe}] 4f^2 5d^0$ changes to $[\text{Xe}] 4f^1 5d^1$

DEAR STUDENTS,

TRY TO WRITE THE ELECTRONIC CONFIGURATION OF 50 ELEMENTS IN YOUR HOME WORK COPY.
