Class 11th | Chemistry

Unit : 1

Structure of Atom

Lecture - 8

Quantum Mechanical Model of Atom

e → particle
→ wave.

- The branch of science that takes into account this dual behaviour of matter is called quantum mechanics.

- Quantum mechanics is a theoretical science that deals with the study of the motions of the microscopic objects that have both observable wave like and particle like properties.

- Quantum mechanics was developed independently in 1926 by Werner Heisenberg and Erwin Schrödinger.

→ e^- → wave equation

Address ???

Country

Shell

City

Subshell

Area

Orbital

House

$e^- \rightarrow$ maximum probability

Shell ↔ orbit

Orbital → e⁻ Max prob.

Location of an Electron

- A large number of orbitals are possible in an atom. Qualitatively these orbitals can be distinguished by their size, shape and orientation.
- An orbital of smaller size means there is more chance of finding the electron near the nucleus.
- Similarly shape and orientation mean that there is more probability of finding the electron along certain directions than along others.

Atomic orbitals are precisely distinguished by what are known as quantum numbers.

Quantum Numbers

Each electron in an atom is identified in terms of four quantum numbers.

- **Principal quantum number(n)**
- **Azimuthal or Orbital or Subsidary quantum number (l)**
- **Magnetic quantum number (m)**
- **Spin quantum number (s)**

Principal Quantum number (n)

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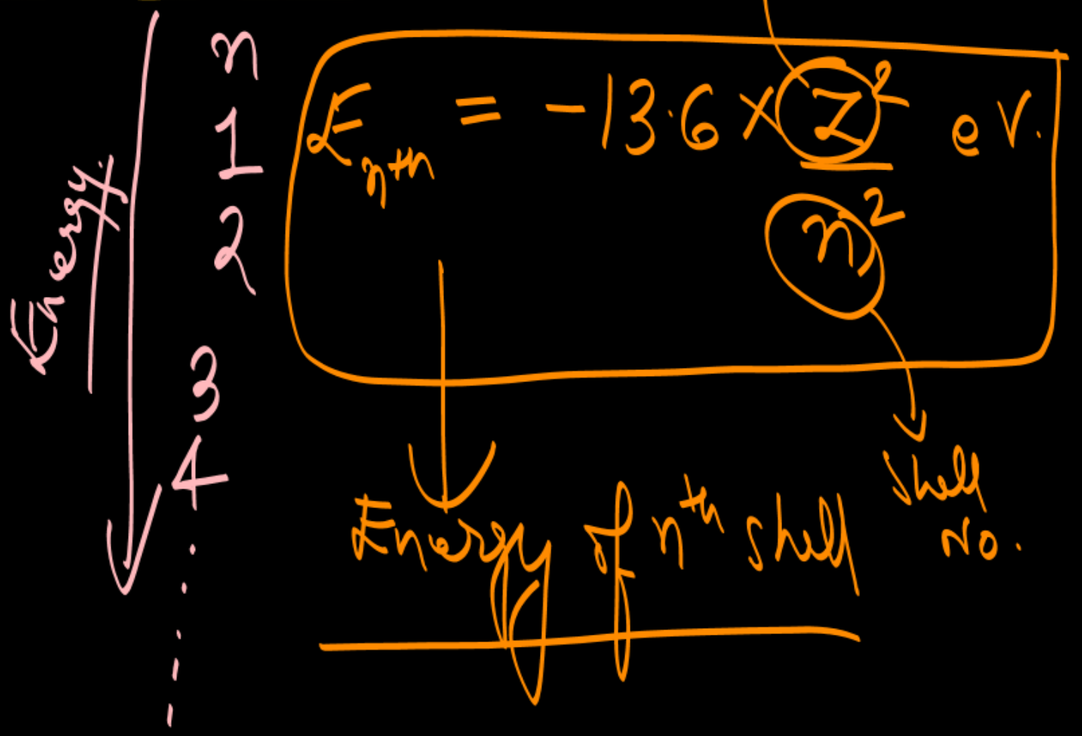
- It tells us about the main shell in which electron resides. It also gives an idea about the energy of shell and average distance of the electron from the nucleus (Size).

Value of n = any integer.

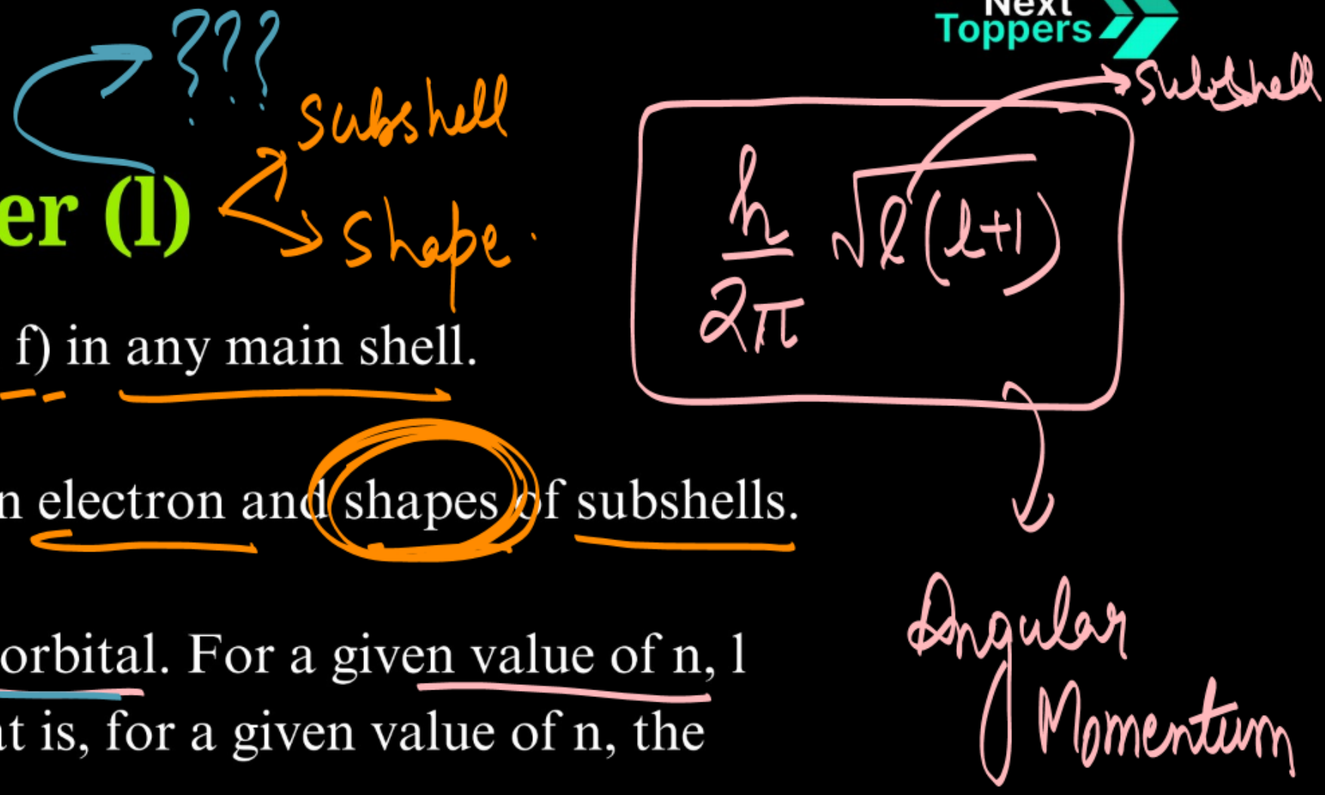
n= 1,2,3,4... for shell K, L, M, ..

K L M N

$n \neq 0$



Azimuthal Quantum number (l)



- It tells about the number of subshells (s. p, d, f) in any main shell.
- It also represent the angular momentum of an electron and shapes of subshells.
- It defines the three-dimensional shape of the orbital. For a given value of n, l can have n values ranging from 0 to n - 1, that is, for a given value of n, the possible value of l are : l = 0, 1, 2, ... (n-1)

For example, when n = 1, value of lis only 0. For n = 2, the possible value of l can be 0 and 1. For n = 3, the possible l values are 0, 1 and 2.

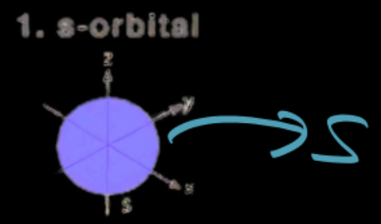
S → spherical, p → dumbell, d - double dumbell.
f → complex shape //

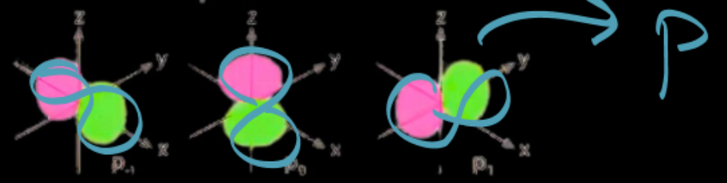
Azimuthal Quantum numbers also tells about the shape of the orbital .

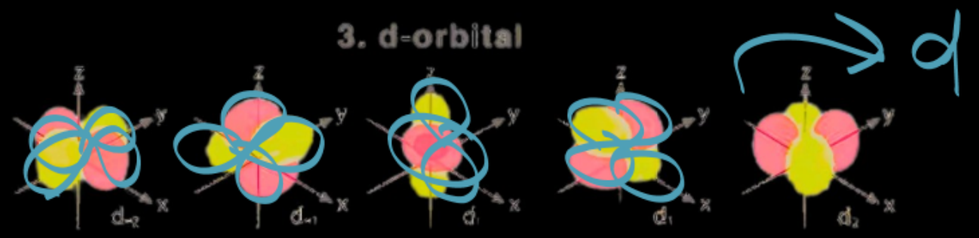
Note– Orbital is the 3–D discription where the probability of finding an electron is maximum.

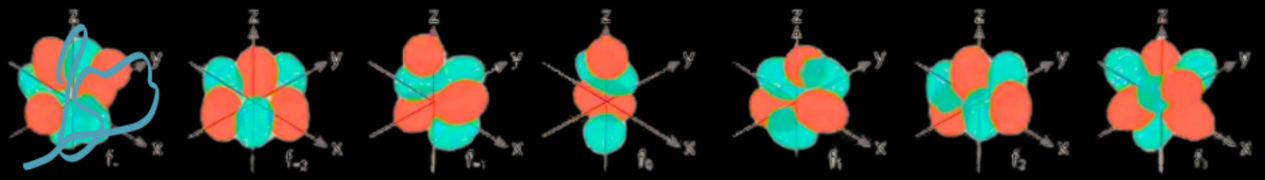
n	l
1	0 → s
2	0 → s, 1 → p
3	0, 1, 2
4	0, 1, 2, 3

$0 \leq l \leq n-1$







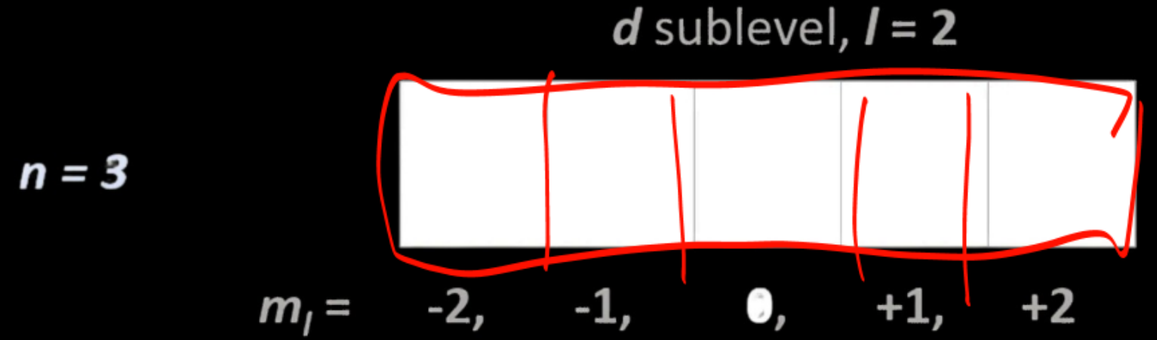


Magnetic Quantum number (m)

- It tells about the number of orbitals and orientation of each subshell.
- Value of m = -l to +l including zero.
- Number of orbitals in each subshell = $(2l + 1)$

$$-l \leq m \leq +l$$

- Number of orbitals in main energy level = n^2



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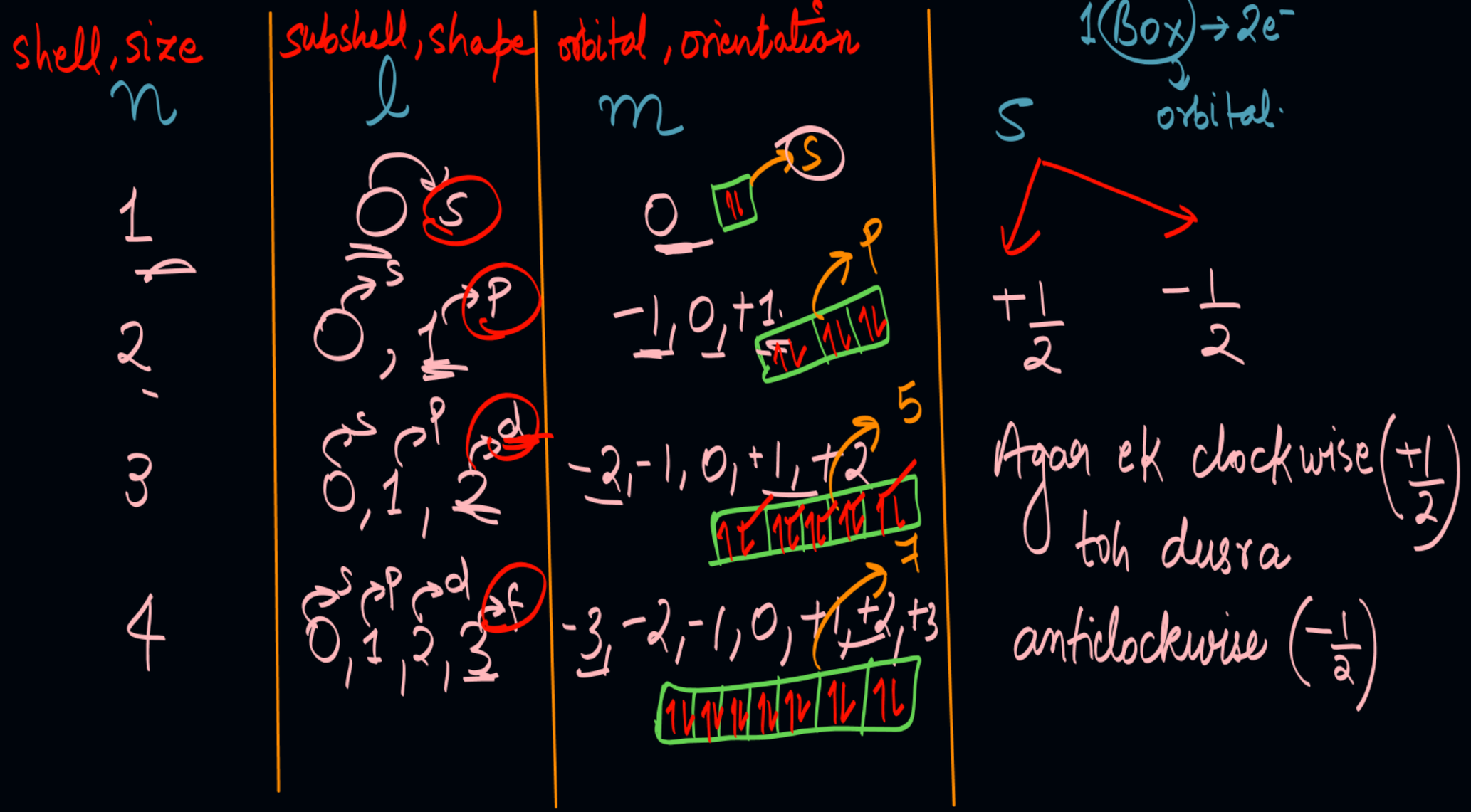
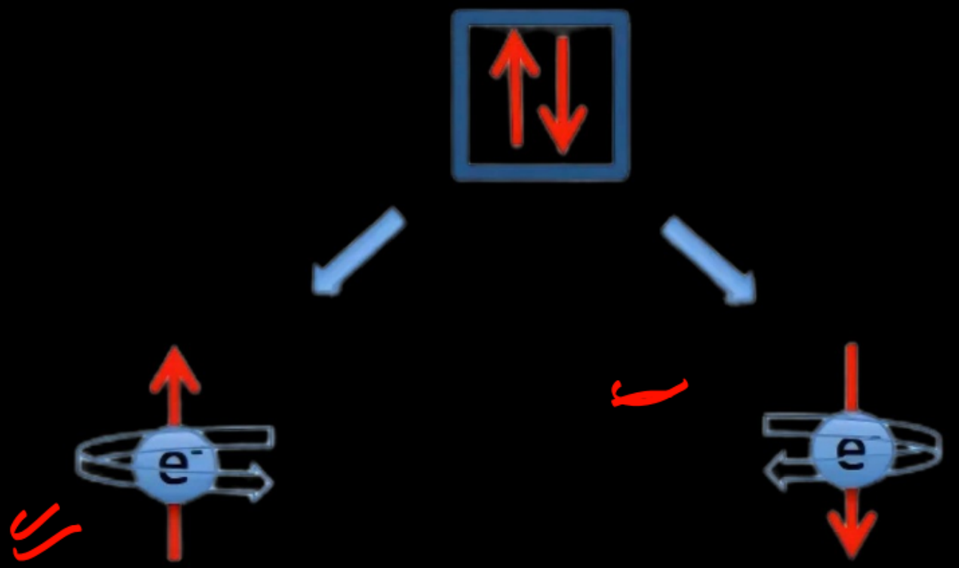

shell, size
n
subshell, shape
l
orbital, orientation
m
1
2
3
4
0
s
0, 1
p
0, 1, 2
d
0, 1, 2, 3
f
0
-1, 0, +1
-2, -1, 0, +1, +2
-3, -2, -1, 0, +1, +2, +3
1 Box → 2e⁻
orbital
s
+1/2
-1/2
Agar ek clockwise (+1/2)
toh dusra
anticlockwise (-1/2)

Spin Quantum number (s)

- It indicates the direction of spinning of electron, i.e., clockwise or anti-clockwise.
- Shows how the electron can rotate about its own axis .
- Maximum number of electrons in main energy level = $2n^2$.



$m_s = +1/2$ $m_s = -1/2$

Formulas

- No. of subshell in a shell = no. of shell
- No. of orbitals in a shell = n^2
- No. of orbitals in a subshell = $2l+1$
- No. of elctron in an orbital = 2 electron
- No. of electron in a subshell = $2(2l+1)$

for d subshell
e???

$2(2l+1) = 2(2\times2+1) = 2(5)$
$= 10$ electrons.

$2(2\times1+1)$
$2\times3 = 6e^-$

max electron?
d
$10e^-$

d orbital.
$2l+1$
$2\times2+1$
5

s → 0
p → 1
d → 2
f → 3

Kitiar.

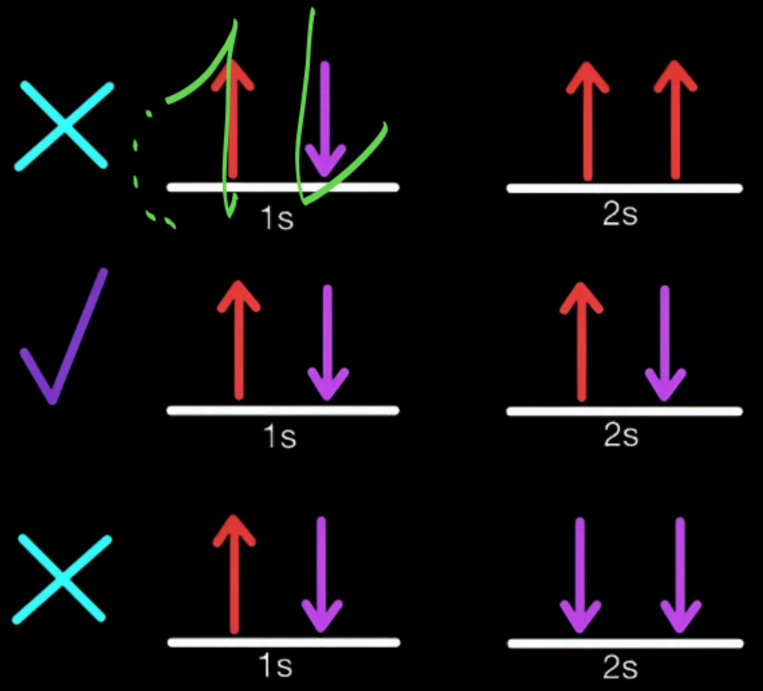
orbitals???
$(2l+1)$
$2\times1+1 \Rightarrow 3$

$s \rightarrow 2e^-$
$p \rightarrow 6e^-$
$d \rightarrow 10e^-$
$f \rightarrow 14e^-$

Pauli Exclusion Principle

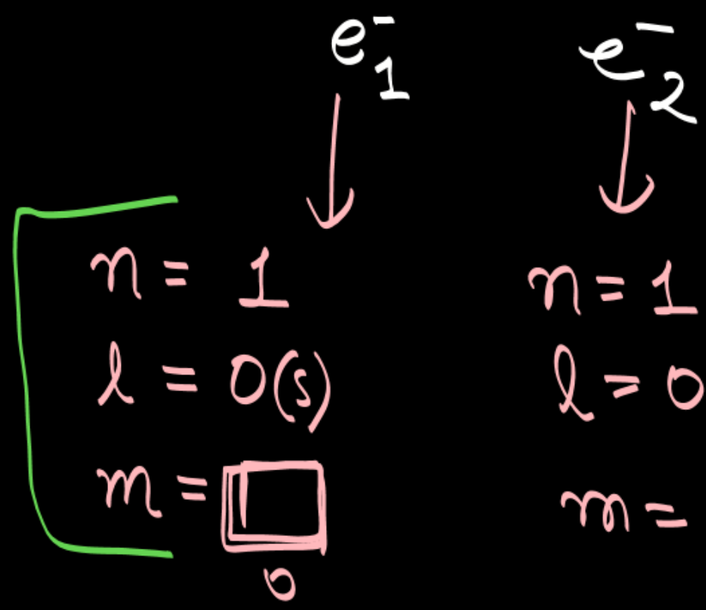
- It states, no two electrons in an atom can have identical set of four quantum numbers.
- Only two electrons may exist in the same orbital and these electrons must have opposite spin"

The maximum number of electrons in s subshell is 2, p subshell is 6 d subshell is 10 and f subshell is 14.



S → 2, p → 6e⁻, d → 10e⁻, f → 14e⁻

EXAMPLE



$S \rightarrow$ C. wise
↳ Anticlockwise

$S \rightarrow$ Anticlockwise
C. wise

Kiliar?

4 same set of Q. Numbers.

↓

Not Possible

Next Toppers

Khatam !
Tata !!
Bye-Bye !!!

Revise ✓

Kal → 5 p.m.

Fir Mileinge...