Unit -1.1; ↓ QUANTUM NUMBERS: - The Quantum Numbers are the details that are required to locate an electron in an atom. In order to specify the energy,size,shape and orientation of the electron orbital the Quantum Numbers are required.

Quantum Numbers - Types:-

The Four quantum numbers are,

1. Principal quantum number (n)
2. Angular momentum quantum number (I).
3. Magnetic quantum number (m)
4. Spin quantum number (s)

1.Principal quantum number (n):-

1. Principal Quantum number represent the main energy level in which electron is present.

2. The Principal Quantum number is represented by the letter ‘n’

3. Principal Quantum number (n) has values like 1,2,3,4 ….(any +ve integral values). These are also called K, L, M, N –shells respectively.Theoretically,there is no limit to the number of shells, but seventh shell (n=7) is the highest shell occupied by the known elements.

4.The first level n = 1, is known as K-shell.Second level (n=2) as L-shell.

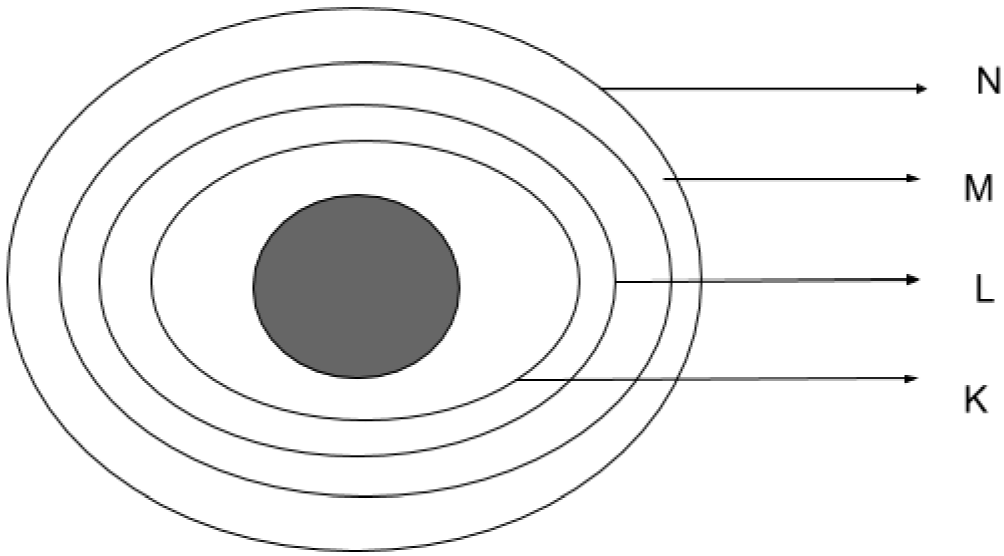
n = 1 => K - energy level (smallest energy)

n = 2 => L –shell ↓

n = 3 => M- shell

n = 4 => N –shell (highest energy)

So the closest shell to the nucleus is the K-shell.



5. Each energy level has a specific energy.So principal Quantum number "n "determines the energy of an electron.

6. As the value of 'n' increases,the electron gets far away from nucleus and its energy increases.This is because the electrostatic energy of attraction is inversely proportional to the distance of the electron from the nucleus and it has the negative sign ($E \alpha - 1/n^2$) . K -has a very low energy. This is because the attraction to the nucleus and the electron at the K-energy level is high. As the principal quantum number value of an electron increases, so does its energy. This is because the distance from the electron to the nucleus increases.

n Values 1 <2 <3 <4

E values E1 <E2 <E3 <E4

7. The 'n' also gives maximum number of electrons that a shell can hold is denoted by the formula **"$2n^2$"**.

Principal Quantum number	maximum of electrons
n = 1	2
n = 2	8
n = 3	18
n = 4	32
n = 5	50

2. Auxiliary or Angular quantum number (l) (Azimuthal quantum number or orbital quantum number.)

I) Angular quantum number represents the sub-shell to which the electron belongs.

ii) We denote this by the symbol “l”.

iii) The values of l depend on the value of n, i.e. l = 0,1,2, ……, (n-1).

iv) Each value of ‘l’ indicates a specific auxiliary energy level. The values of l are 0,1,2,3,4 which represent the sub-energy levels s, p, d, f, g respectively.

If n = 1, l = 0 (only one value) => 1s - subshell

If n = 2, l = 0,1 (two values - hence two auxiliary energy levels)

l = 0 => 2s subshell

l = 1 => 2p subshell

If n = 3, l = 0,1,2 (three values - hence three sub-energy levels)

l = 0 => 3s subshell

l = 1 => 3p subshell

l = 2 => 3d subshell

If n = 4, l = 0,1,2,3 (four values - hence four auxiliary energy levels)

l = 0 => 4s subshell

l = 1 => 4p subshell

l = 2 = 4d subshell

l = 3 => 4f subshell

v) The energies of the secondary energy levels are in the following order.

s <p <d <f <g

v) So from the value of l, the shape of the orbital is revealed.

3) Magnetic quantum number (m):-

i. In the strong magnetic field,a sub shell is resolved into different orientations in space. In the absence of magnetic field the orbitals are degenerated (same energy).But in the presence of magnetic field,there are slight differences in energy.This shows the appearance of additional lines in the atomic spectra, when the atom is placed in magnetic field.

ii. Therefore, the magnetic quantum number represents each orbital.We denote the magnetic quantum number by the letter 'm' and its value depends on the value of 'l'.

iii) "m" can have values from - l through zero to + l (i.e., -l,.....0……+l) .

iv) The number of orientations (or orbitals) in a subshell is given by (2l + 1).

Thus,

If l = 0, then m = 0. (Same value) --- s-orbital (having only one value or one orbital).

If l = 1, then m = -1,0, + 1. (Three values) --- three p-orbitals. (p_x, p_y, p_z)

- If l = 2, then m = -2, -1,0, + 1, + 2. (Five values) --- five d-orbitals .

  (d_{xy}, d_{xz}, d_{yz}, d_{z^2}, d_{x2-y2})

- If l = 3, then m = -3,-2,-1,0,+1,+2,+3 (seven values) ---- f-orbitals have seven orbitals.

vi).The total number of orbitals at a primary energy level (n) = **n^2.** (n=Principal quantum number)

For example ,

if n=2, no: of orbitals = **n^2** =2^2 = 4 orbitals (2s + three "p" orbitals)

<u>4) Circulation Quantum number (s) (spin quantum number): -</u>

i) The electron found in an atom not only rotates around the nucleus but also rotates around its axis. This cycle takes place in two ways. (Clockwise, anticlockwise) .So spin or rotation Quantum number, the rotation of an electron Indicates direction.

ii) We denote the spin quantum number by the symbol "s" or ms. Each "m" value has two s-values : s = + 1/2; or -1/2.

So, the value of spin quantum number refers to the direction of the spin of the electron.
