CLASS - BSc(Sub/GEN) PART - I

GROUP - B

TOPIC quantum numbers.

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Quantum Numbers: Quantum numbers are the numbers which provide us a mathematical basis for expressing the position and behaviour of electron in atom like the address of a person.

The position and energy, Collectively Called the State of an electron in any atom Can be described by a Set of following four quantum numbers —

(a) Principal quantum number, n

(b) Azimuthal quantum number, l

(c) Magnetic quantum number, m

(d) Spin quantum number, s

The quantum numbers n, l and m their relationships are obtained from the Solutions of 2nd order differential Schrodinger wave equation and the Spin quantum number arises from the Spectral evidence that the electron in its motion round the nucleus also rotates or spins about its own axis.

(a) Principal quantum number: It is denoted by n. It has values 1, 2, 3.. It is written first in the electronic Configuration of elements. It is Simply the orbit number. It provides information about the Size (or radius) of the atom (r) and the energy of an electron in the atom (E)

$$r = 5.28 \times 10^{-11} \times \frac{n^2}{Z^*}$$

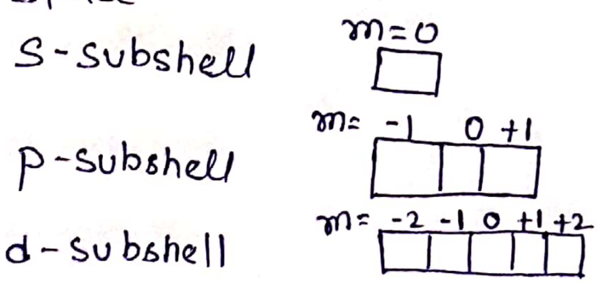
$$E = -2.18 \times 10^{-18} \times \frac{Z^{*2}}{n^2} \text{ Joules.}$$

(b) Azimuthal quantum numbers: It is denoted by l. It is related to Subshells s, p d and f. l can have all possible whole number values from zero to $(n-1)$ if $n = 1$, l has a value zero.

Hence there will be only one Subshell i.e s if n = 2 l will have Values 0 (s) and 1 (p). This implies that an electron with n = 2 may be located either in 2s or 2p Subshell. Similarly n = 4, l will have values of 0, 1, 2 and 3 i.e, There will be 4s, 4p, 4d and 4f Subshells in the 4th orbits. Total energy of an electron is partly associated with the angular momentum of the electron around The nucleus of the atom. Therefore it is also called as angular momentum quantum number. This provides informations regarding the shape of Subshells occupied by the electron and the angular momentum of the electron.

l values	0	1	2	3
Subshell	s	p	d	f

(c) Magnetic quantum number: It is denoted by m. the motion of electron in orbit is Just like a flow of electricity through a loop. Hence it produces a magnetic field due to which electrons orient Themselves in certain orbitals in a given Subshell within a principal energy level. the possible values of m range from -l through zero to +l i.e a total of 2l+1 values. If l = 0 (s), m can have only one value 0 i.e, s-subshell Can have only one orbital. If l = 2 (d), m Can have five values -2, -1, 0 +1 +2. This implies That d-Subshell Can have five orbitals i.e five possible orientatio in space. Similarly, we Can have three and Seven possible orienta-tions for p (l = 1) and f (l = 3) subshells. Thus magnetic quantum numbers tells us regarding the possible orientations of orbitals in space



f-Subshell $m = -3 \ -2 \ -1 \ 0 \ +1 \ +2 \ +3$

(d) spin quantum number: It is denoted by s. It does not depend upon other three quantum numbers. Electron has intrinsic angular momentum or spin. The magnitude of spin angular momentum $= \sqrt{s(s+1)}\frac{h}{2\pi}$. the presence of doublets in the fine structures of spectra of alkali metals shows that the spin angular momentum can have only two orientations along any physically established axes, specified by a quantum number m_s, where $m_s = +\frac{1}{2}(\uparrow)$ or $-\frac{1}{2}(\downarrow)$. So the spinning of an electron also contributes to the angular momentum of the electron and therefore to its total energy $+\frac{1}{2}$ and $-\frac{1}{2}$ values denote the clockwise and anticlockwise spin of electron. Hence this quantum number explains the spin of electron.