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Inorganic.

Chapter - At. structures.

Topics — ① Quantum-Numbers.
② ~~Pauli's Exclusion Principle~~

Quantum- Numbers.

As we know that a large number of electron-orbitals are possible in atom having different- Size, Shape & Orientation.

To describe each electron in an atom we need a set of three number called Quantum Number.

The three quantum-numbers is the result of Schrodinger wave-eqn. the value of $\psi = \theta, l, r$

θ = Magnetic Q.N (m)
l = Azimuthal Q.N (l)
r = Principal Q.N (n)

In addition to these three, the another number also needed to represent the spin of electron.

Thus there are four Q.N.

Def :— The Q.N gives full idea about the electron like nature of orbits, sub-orbit, sub-sub-orbit (orbital),

& spining of electron in three dimensional space within an atom.

① Principle q.N.:(n)
first of all this q.N is introduced by bohr.

$$mvr = \frac{nh}{2\pi}$$ | n = Integral No = Principle q.N

Idea from P.q.N(n)

ⓐ It determines the main-energy shell or level in which electron is present. Basically nature of orbit.

Value of n →	1	2	3	4	5	
nature of orbit →	K	L	M	N	O	–

ⓑ Averaged distance of electron from the nucleus.

$$r_n = \frac{0.529 \times n^2}{Z}$$

ⓒ Energy of electron in their orbits.

$$E_n = \frac{-13.6 \times Z^2}{n^2}$$

ⓓ Velocity of electron in that orbit

$$V_n = \frac{2.18 \times 10^6 \, m/s}{n} \times Z$$

ⓔ Number of Max. electron in given orbit. → $2n^2$

n = No of orbit

Remember:– 4th & next higher always

(2) Azimuthal q.n (l) –

Orbit is also sub divided into some sub-orbits of energy called subshell/ sub-level or sub energy level.

It is also called as the angular momentum or subsidiary q.n

Rules for Az. q.n (l)

(1) The value of l depends upon n-value. For any value of n, l value ranging from 0 to $(n-1)$

$l = 0$ to $(n-1)$

(2) The angular momentum of electron in an orbit is given by

$$= \frac{h}{2\pi}\sqrt{l(l+1)}$$

(3) The value of l indicates the volume, shape & energy level of subshell in a major energy shell.

Value of l	Sub-shell	Shape	origine name	Design
0	s	Spherical	Sharp	
1	p	Dumbell	Principal	
2	d	Double dumbell	Diffuse	
3	f	dumbell	fundamental	X

(d) Max. number of electron in Sub-Shell.

Sub-Shell	l-value	$2(2l+1) = (4l+2)$	Max. electron.
s	0	$4\times0+2$	$= 2$, s^2
p	1	$4\times1+2$	$= 6$, p^6
d	2	$4\times2+2$	$= 10$, d^{10}
f	3	$4\times3+2$	$= 14$, f^{14}

(e) Number of Subshell in given shell.

n-value	Shell	Sub-shell ($l = 0, 1, 2, (n-1)$)	Design.
1	K	one	1s
2	L	Two	2s, 2p
3	M	Three	3s, 3p, 3d
4	N	Four	4s, 4p, 4d, 4f

Only four subshell is known.

(f) energy order of the subshell —

Energy order → $f > d > p > s$

(3) Magnetic Q.N (m)

It describe the behaviour of electron in a magnetic field. Movement of electrical charge is always associated with magnetic ~~pol~~ moments.

The above magnetic

field interact with external magnetic field of the earth.

Under the influence of magnetic field (Zeeman-effect) the electrons in a given shell orient in various region of space round the nucleus called orbitals.

Idea from M.Q.N (m)

(c) Number of Orbitals in a given Sub-shells.

The value of m ranging from $\pm l$ to zero.

l-value	sub-shell	m-value $= \pm l$ to 0	Number of orbitals
0	s	0	1
1	p	−1, 0, +1	3
2	d	−2, −1, 0, +1, +2	5
3	f	−3, −2, −1, 0, +1, +2, +3	7.

Designation of orbitals & their m-value.

$l=0, m=0 \rightarrow s$

$l=1, m= \pm 1 \left< \begin{matrix} p_x \\ p_y \end{matrix} \right., \; 0 = p_z$

$l=2, m = \pm 2 \left< \begin{matrix} d_{xy} \\ d_{x^2-y^2} \end{matrix} \right.$

$= \pm 1 \left< \begin{matrix} d_{xz} \\ d_{yz} \end{matrix} \right.$

$= 0 \rightarrow d_{z^2}$

$l=3, m = \pm 3$ & zero.

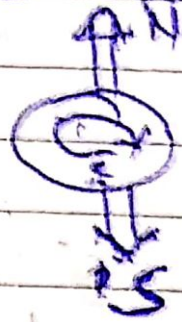
Remarks :- Any orbitals occupies max. two electrons

(4) Spin Q.N (s) :- Electron in an atom is not only revolving around the nucleus but also spinning around its own-axis.

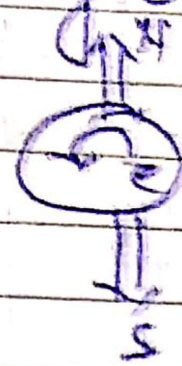
idea from S.Q.N

(a) S- have only two-values $s = \pm 1/2$

(b) Its value only signifies the direction of rotation or spin of an electron upon its axis during motion.



clockwise $s = +1/2$ (↑)



anticlockwise $s = -1/2$ (↓)

(c) Spin angular-momentum is given

$$\frac{h}{2\pi}\sqrt{s(s+1)}$$

$$= \frac{h}{2\pi}\sqrt{\frac{1}{2}\left(\frac{1}{2}+1\right)}$$

$$= \frac{h}{2\pi}\sqrt{\frac{3}{4}}$$

$$= \frac{\sqrt{3}h}{4\pi}$$

for one electron $s = +1/2$