CONCEPT MAP

STRUCTURE OF ATOM

The development of a suitable and general model of atoms was mainly based upon two concepts.

Dual nature of matter and light

The wave associated with a particle is called a matter wave or de-Broglie wave and its wavelength was calculated by analogy with photon.
de Broglie's relation-ship,

$$\lambda = \frac{h}{mv} = \frac{h}{p}$$

Heisenberg uncertainty principle

States that it is impossible to determine simul-taneously, the exact position and exact momentum of an electron.

$$\Delta x \times \Delta p \geq \frac{h}{4\pi}$$

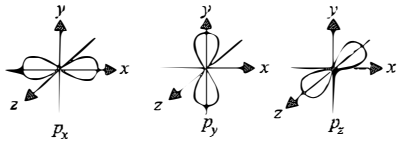
Concept of orbital

Three dimensional space around the nucleus within which the probability of finding an electron of given energy is maximum is an atomic orbital. The maximum number of electrons present in any orbital is 2.

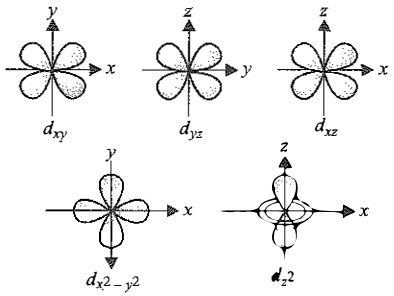
Shapes of atomic orbitals

→ *s*-orbitals (spherical)

→ *p*-orbitals (dumb-bell)



→ *d*-orbitals (d_{xy}, d_{yz}, d_{xz}, $d_{x^2-y^2}$) clover leaf shape, d_{z^2} (doughnut shape)



Quantum numbers

Each electron is characterised by a set of four numbers called quantum numbers.

Principal quantum number (*n*)
- Determines the main energy shell or level in which the electron is present.
- $n = 1, 2, 3, 4, \ldots$

Azimuthal (angular) quantum number (*l*)
- Gives the subshell or sub-level in a given principal energy shell to which an electron belongs.
- $n = 0, 1, 2, 3, (n-1)$
- Determines the angular momentum of the electrons.
- $l = 0, 1, 2, 3, \ldots$
  $s, p, d, f, \ldots$

Magnetic quantum number (*m*)
- Gives different orientations of the orbitals in space.
- $m = -l, \ldots 0 \ldots +l$
- For each value of l, there are $(2l + 1)$ values of m.

Spin quantum number (*s*)
- Describes the spin orientation of the electron.
- $s = +1/2$ or $-1/2$ (two orientations clockwise or anti-clockwise respectively)

Electronic configuration

The distribution of electrons in different orbitals.

Aufbau principle
In the ground state of an atom, an electron enters the orbital of lowest energy first and subsequent electrons are fed in the order of increasing energies.

Bohr Bury's rule ($n + l$ rule)
Orbitals fill in the order of increasing value of $(n + l)$.
If the two orbitals have same $(n + l)$ value then the orbital with lower value of n will be filled first.

Pauli's exclusion principle
No two electrons in an atom can have same set of values for all the four quantum numbers.
An orbital can accomm-odate maximum of two electrons.

Hund's rule of maximum multiplicity
Electron pairing will not take place in orbitals of same energy until each orbital is singly filled.