GOVT. NAVEEN GIRLS COLLEGE BAIKUNTHPUR

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(DEPARTMENT OF CHEMISTRY)

INORGANIC CHEMISTRY

UNIT :- 01

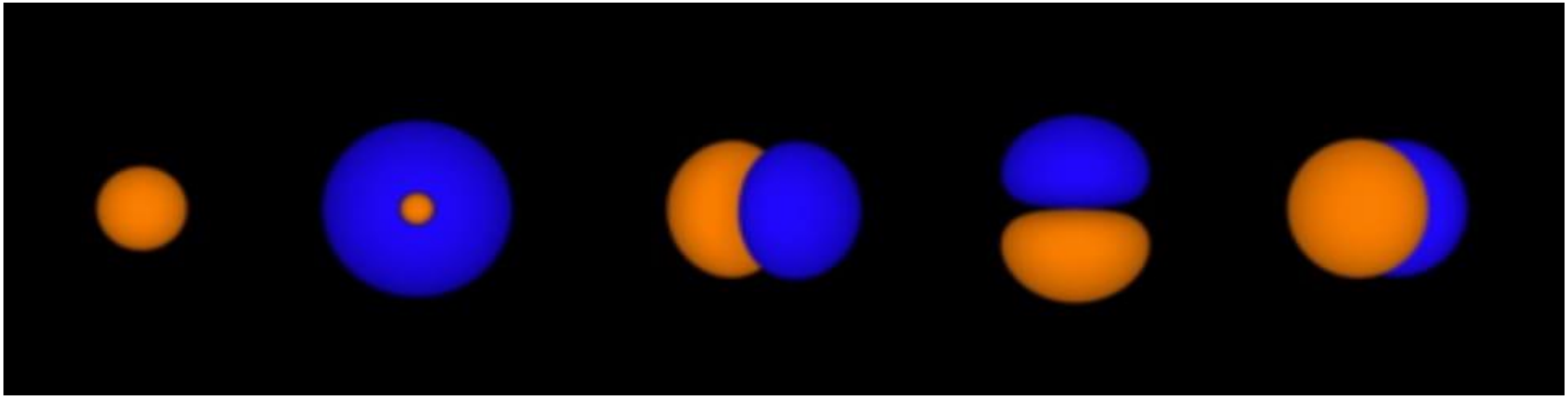
(Atomic Structure)

TOPIC :- ATOMIC ORBITAL

In **atomic theory** and **quantum mechanics**, an atomic orbital is a **mathematical funcion,** describing the location and wave-like behavior of an electron in **atom**. This function can be used to calculate the **probability** of finding any electron of an atom in any specific region around the **atom's nucleus**. The term *atomic orbital* may also refer to the physical region or space where the electron can be calculated to be present, as predicted by the particular mathematical form of the orbital.

- Each orbital in an atom is characterized by a unique set of values of the three **quantum numbers** n, ℓ, and m, which respectively correspond to the electron's **energy**, **angular momentum**, and an angular momentum **vector component** (the **magnetic quantum number**).

- The simple names **s orbital**, **p orbital**, **d orbital**, and **f orbital** refer to orbitals with angular momentum quantum number $\ell = 0, 1, 2$, and 3 respectively. These names, together with the value of n, are used to describe the electron configurations of atoms.

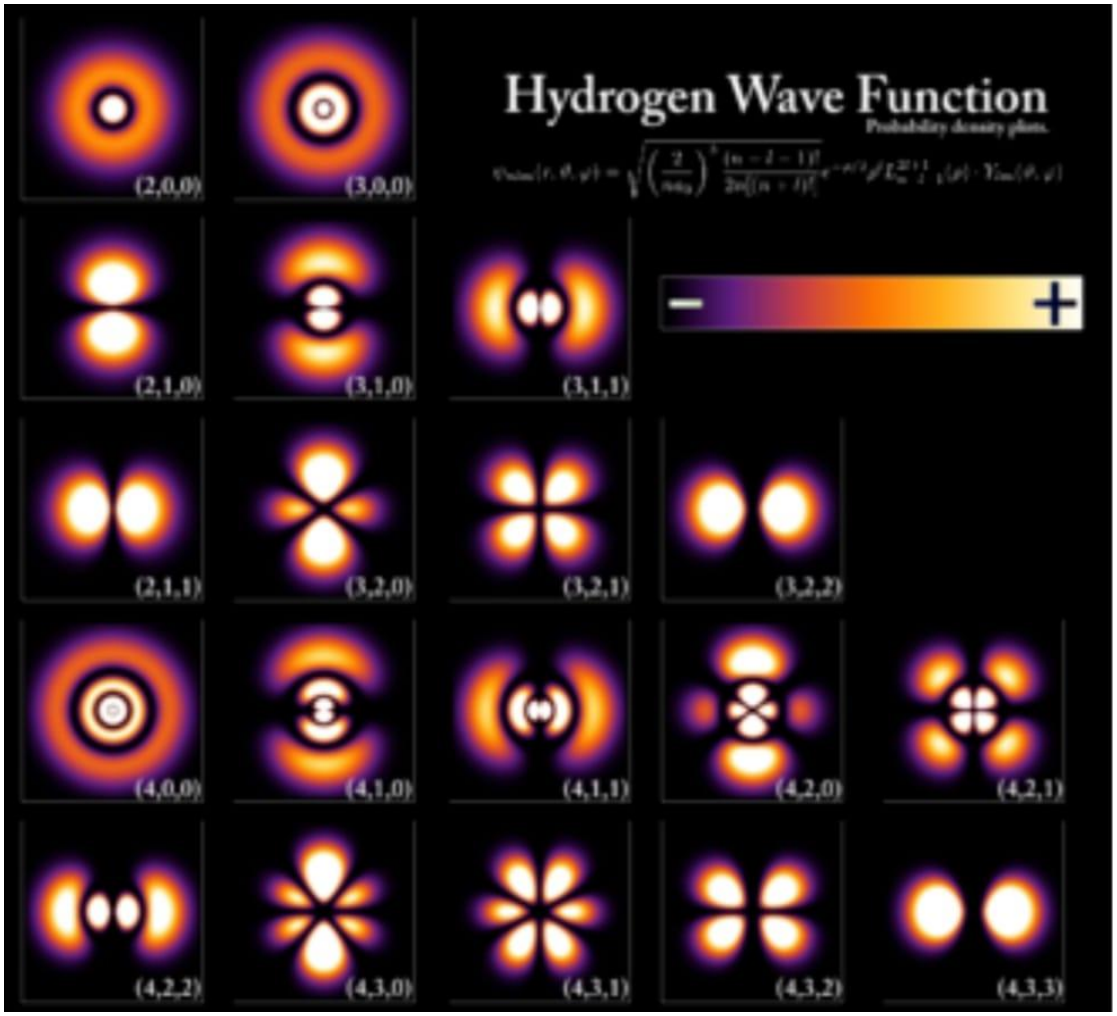


The shapes of the first five atomic orbitals are :- 1s, 2s, $2p_x$, $2p_y$, and $2p_z$.

- Atomic orbitals are the basic building blocks of the **atomic orbital model.**

- The repeating *periodicity* of the blocks of 2, 6, 10, and 14 elements within sections of the periodic table arises naturally from the total number of electrons that occupy a complete set of **s**, **p**, **d**, and **f** atomic orbitals, respectively.

(e.g.):- $Cr = [Ar]4s^1 3d^5$ and $Cr^{2+} = [Ar]3d^4$

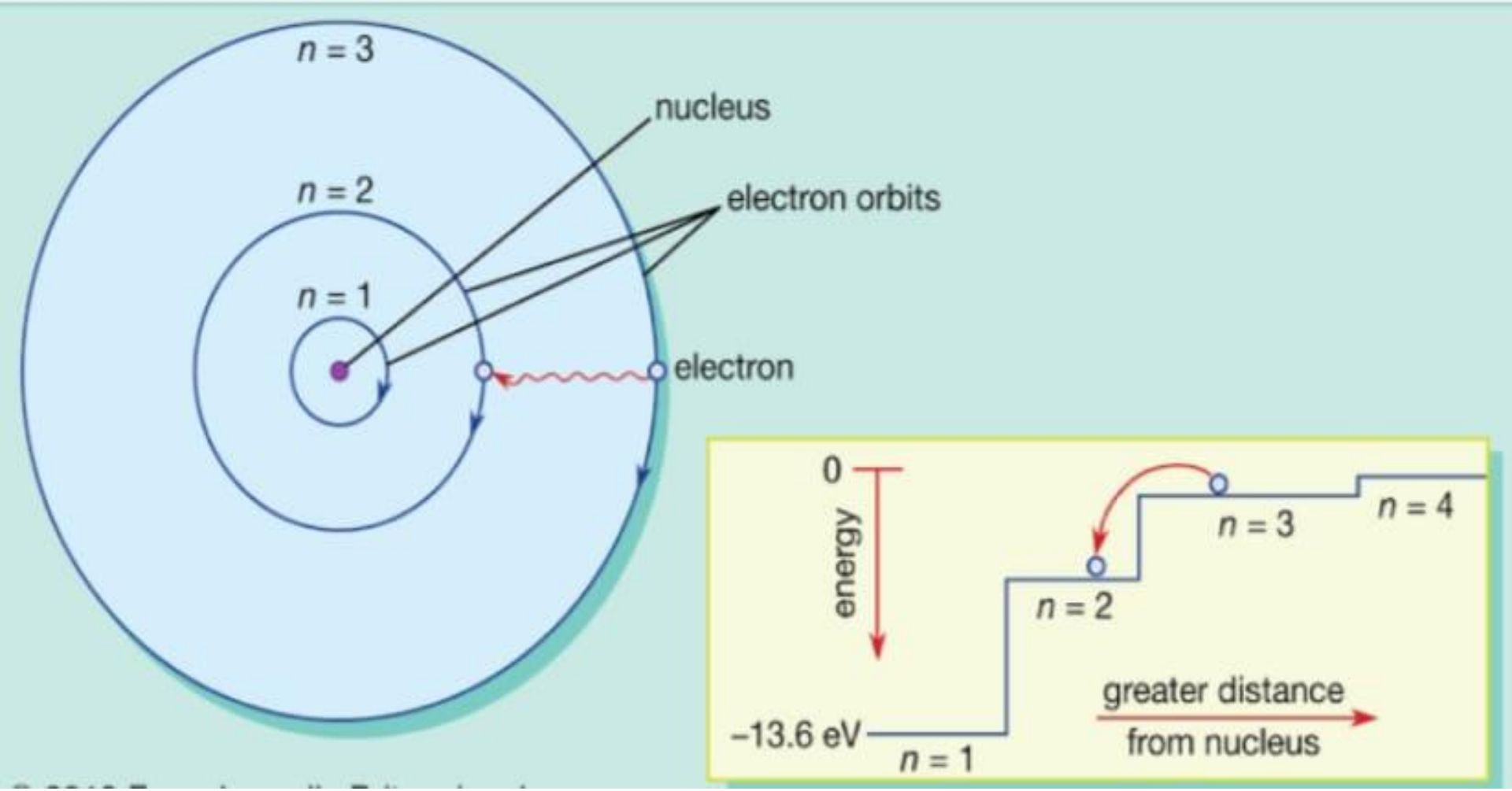


Atomic orbitals of the electron in a hydrogen atom at different energy levels.

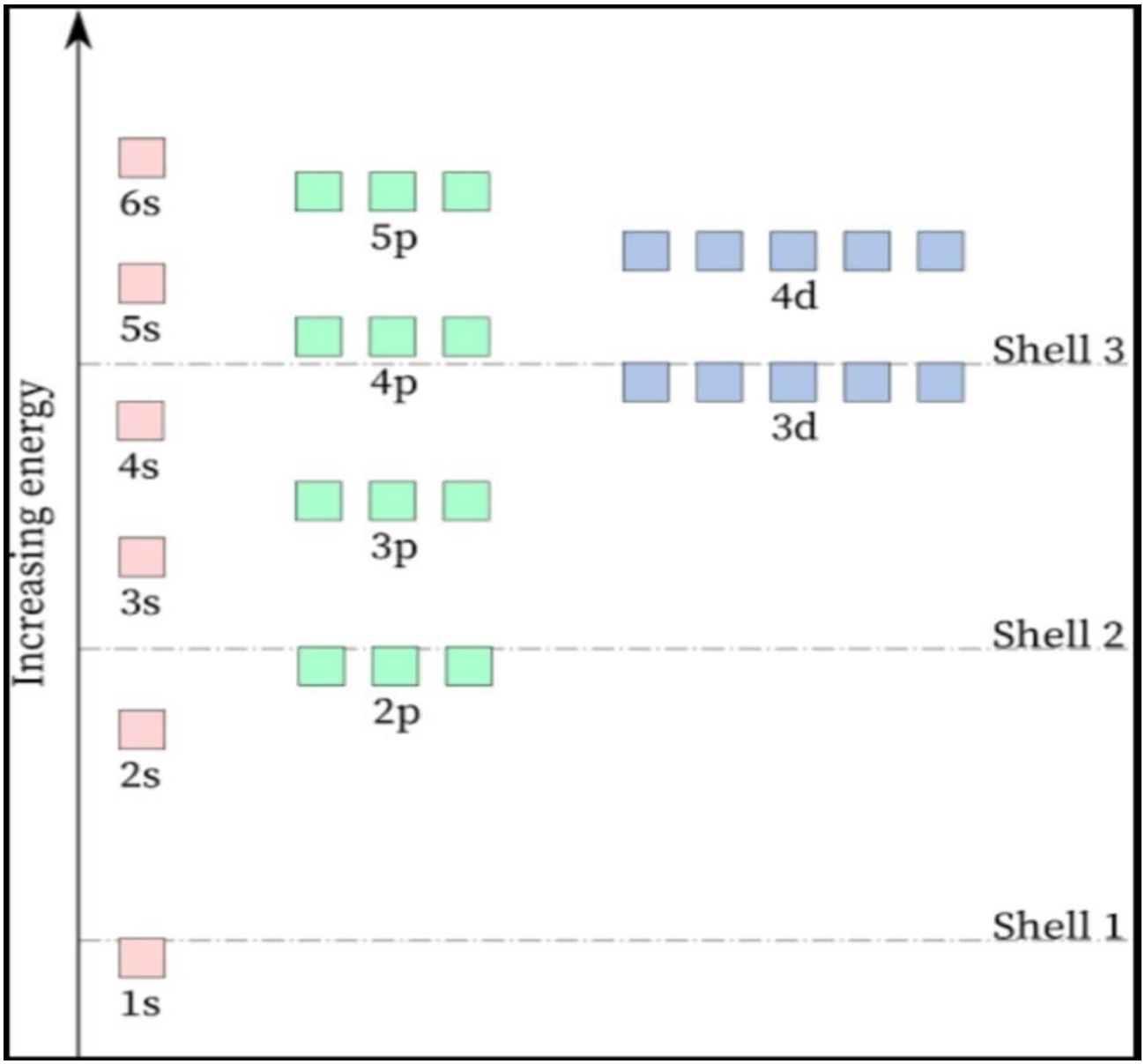
HISTORY :-

The term "orbital" was coined by **Robert Mulliken** in 1932 as an abbreviation for *one-electron orbital wave function*. However, the idea that electrons might revolve around a compact nucleus with definite angular momentum was convincingly argued at least 19 years earlier by **Niels Bohr**, and the Japanese physicist **Hantaro Nagaoka** published an orbit-based hypothesis for electronic behavior as early as 1904. Explaining the behavior of these electron "orbits" was one of the driving forces behind the development of quantum mechanics.

ORBITAL ENERGY :-

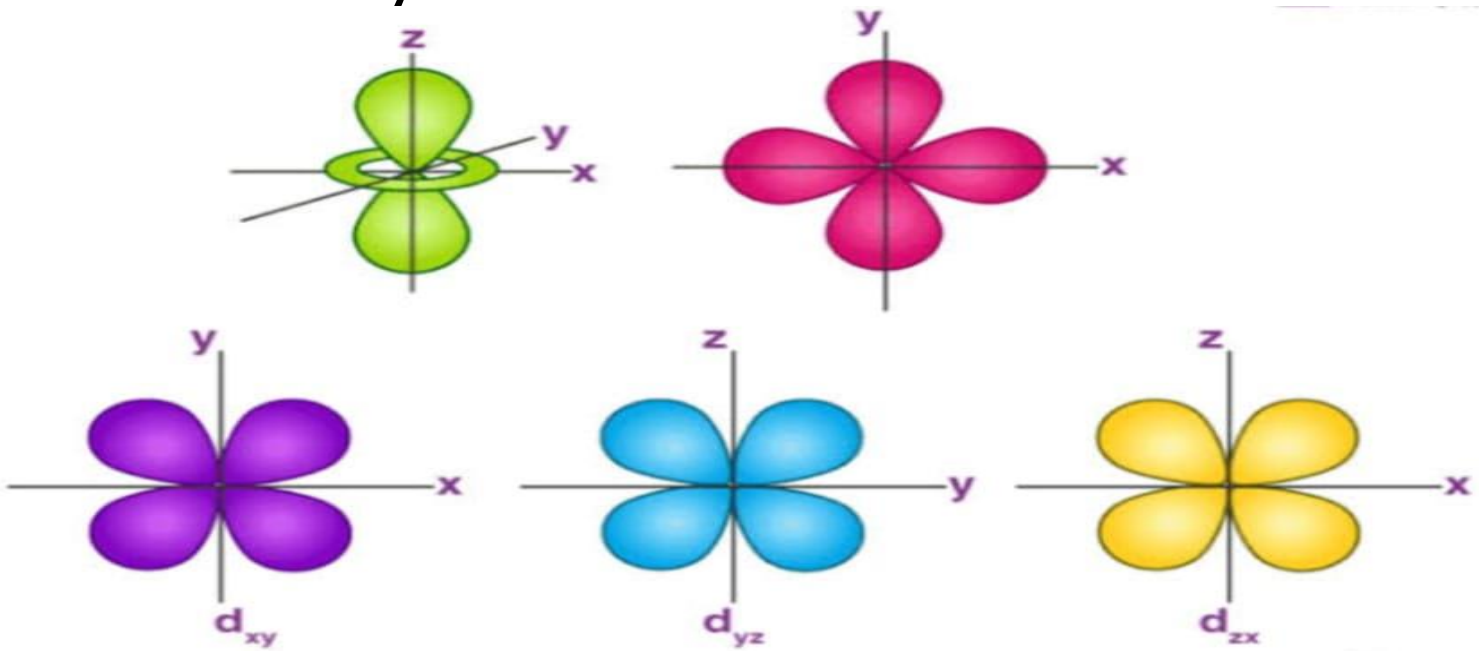


The energy of orbitals refers to the energy required to take an electron present in that orbital to infinity or the energy released when an electron is added to that orbital from infinity. The energy of orbital depends on principle quantum number (n) and azimuthal quantum number (l) it depends on shell and subshells.

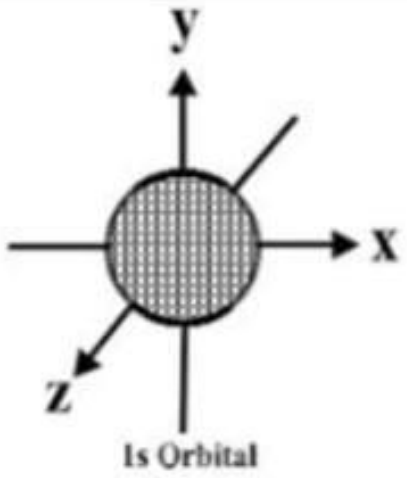

Increasing energy
6s
5s
4s
3s
2s
1s
5p
4p
3p
2p
4d
3d
Shell 3
Shell 2
Shell 1

ORBITAL SHAPE :-

- There are four different kinds of orbitals, denoted s, p, d and f each with a different shape. Of the four, s and p orbitals are considered because these orbitals are the most common in organic and biological chemistry.



- An s-orbital is spherical with the nucleus at its centre, a p-orbitals is dumbbell-shaped and four of the five d orbitals are cloverleaf shaped.
- The fifth d orbital is shaped like an elongated dumbbell with a doughnut around its middle.
- The orbitals in an atom are organized into different layers or electron shells.



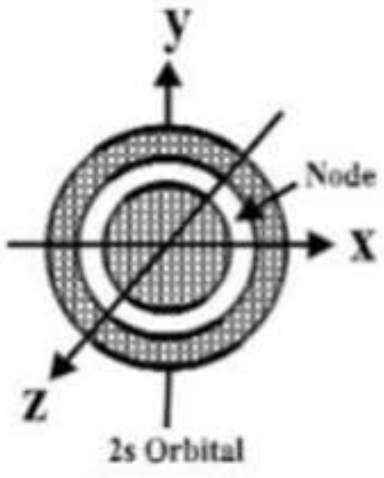


Fig. Shapes of 1s and 2s-orbitals

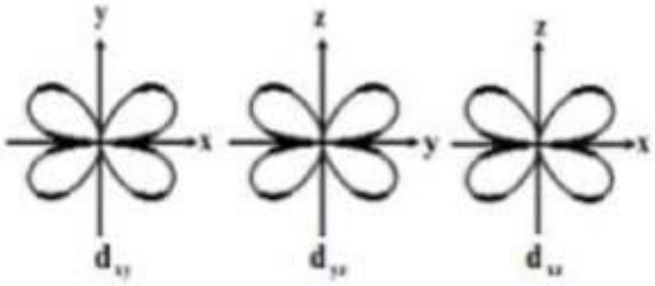


Fig. Shapes of d-orbitals

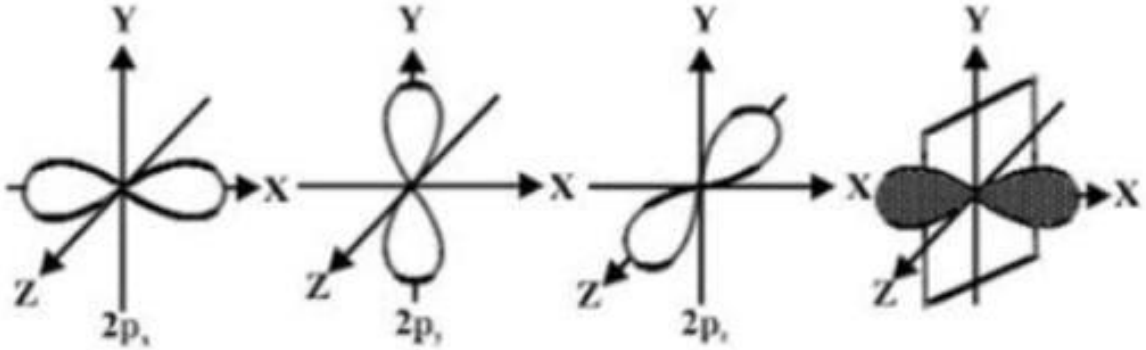


Fig. Shapes of $2p_x$, $2p_y$ and $2p_z$ orbitals

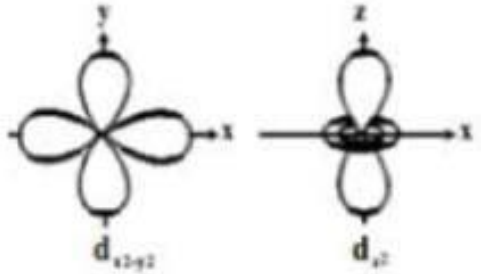


Fig. Nodal plane for $2p_x$ orbital

THANK YOU.....