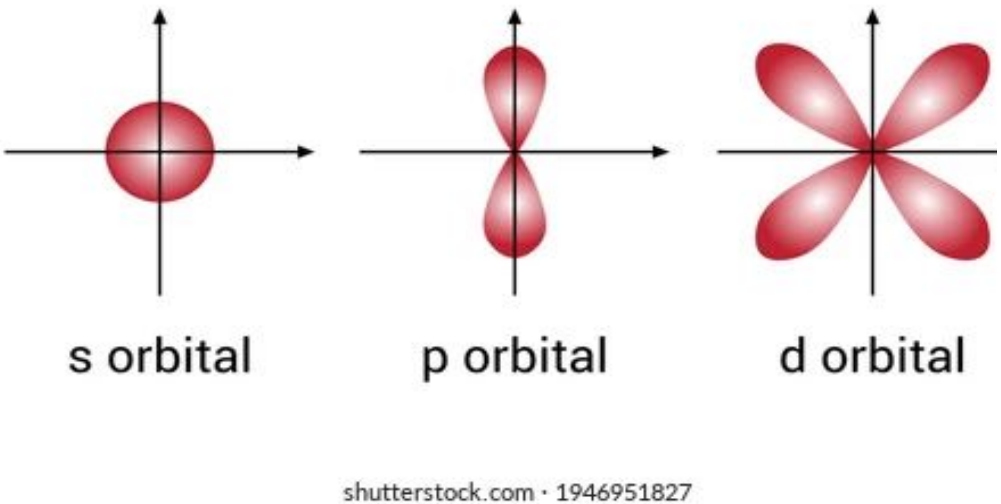
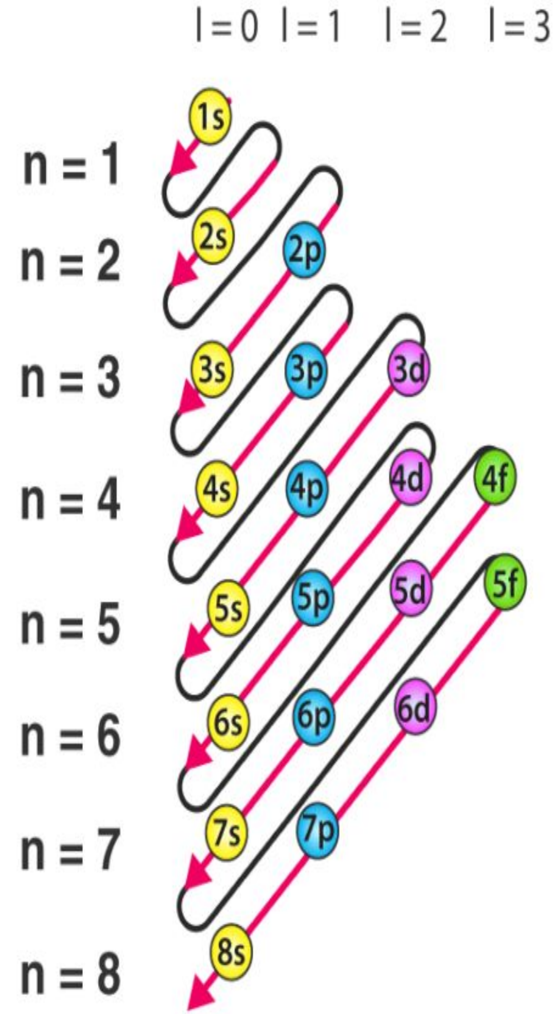
Electrons levels and sublevels. Quantum number. Electron configuration

Brainstorming





- Make a list of inferences about any properties of objects in the box.
- How could you learn more about the objects in the box without opening the box?
- Scientist face these same questions as they try to learn more about atoms.

Quantum Numbers

- **Quantum numbers** specify the address of each electron in an atom. There are four types of quantum numbers:
- 1. Principal quantum number, n → energy level (shell)
- 2. Secondary quantum number, l → *subshell (s, p, d, f)*
- 3. Magnetic quantum number, m_l → orbital
- 4. Spin quantum number, m_s → spin type of
  - There are no two electrons in an atom that can have the same four quantum numbers. Each electron has a unique address, like a family living in a flat. This is Pauli's Exclusion Principle.

1. The principal quantum number, n

- determines the size and energy of an atom (larger n means bigger atoms and higher energy),
- can take an integer value n = 1, 2, 3, 4 ... or (K, L, M, N...),
- all electrons in an atom with the same value are said to belong to the same shell.

2. Secondary quantum number, l

- determines the overall shape of the orbital within a shell
- affects orbital energies (bigger l = higher energy)
- all electrons in an atom with the same value of ‘l’ are said to belong to the same subshell
- has integer values between 0 and n-1
- may be called the “orbital angular momentum quantum number”

3. Magnetic quantum number, ml

- determines the orientation of orbitals within a subshell
- does not affect orbital energy
- has integer values between -I and +I
- the number of ml values within a subshell is the number of orbitals within a subshell
- s, p, d and f subshells includes 1, 3, 5 and 7 orbitals respectively.

4. Spin quantum number, ms

- each orbital may contain two electrons at most
- several experimental observations can be explained by treating the electron as though it were spinning
- spin affects the electron behave like a tiny magnet
- spin can be clockwise (+1/2) or counterclockwise (-1/2)

Solving problems

Example 1

- Find the values of quantum numbers for hydrogen atom.

Example 2

- Show the values of possible quantum numbers for magnesium atom.(12Mg)

Electron configuration

In 1925 **Wolfgang Pauli** stated his exclusion principle;

- ‘In the same atom, two electrons may not have identical sets of all quantum numbers.’
- According to this principle, the quantum numbers, n, *l*, m_l, *and* m_s, *can never* be identical for two electrons in an atom.

The Aufbau process

- The Aufbau principle basically states that the lowest energy orbitals are filled first.

Hund’s rule states that;

- the electrons are distributed among the orbitals of a subshell of the same energy in a way that gives the maximum number of unpaired electrons with parallel spin.

- **$1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^6$, $4s^2$, $3d^{10}$, $4p^6$, $5s^2$, $4d^{10}$, $5p^6$, $6s^2$, $4f^{14}$, $5d^{10}$, $6p^6$, $7s^2$, $5f^{14}$, $6d^{10}$, $7p^6$**