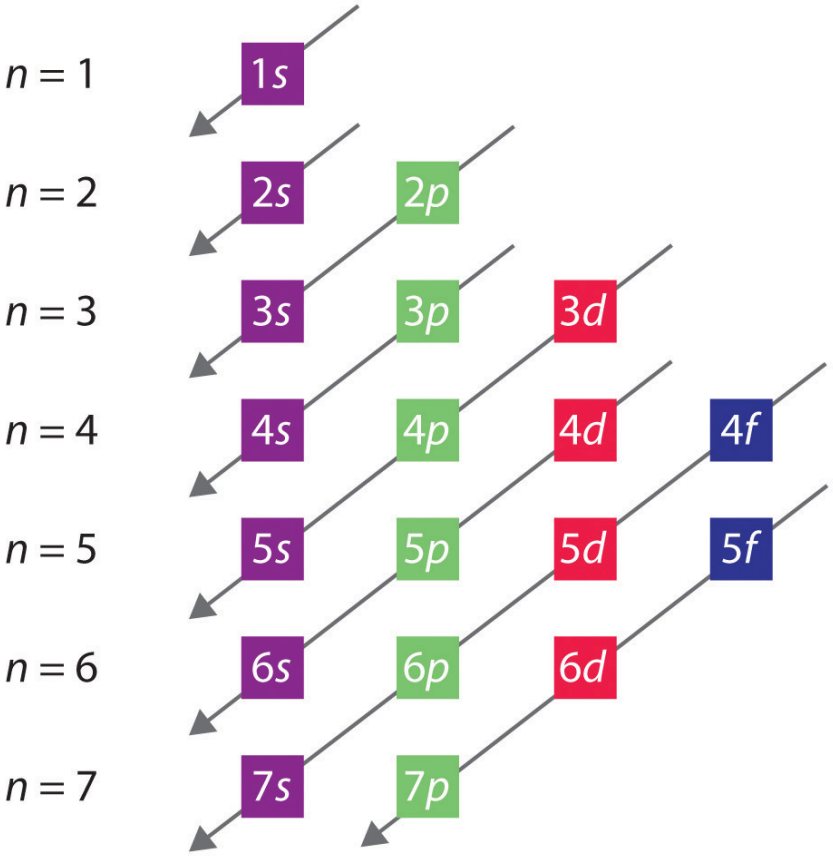
Electrons, energy levels and atomic orbitals

Summary

- Electrons are arranged in shells and sub-shells
- Sub-shells have orbitals which hold electrons
- energy of shells increase with distance from the nucleus
- The principle quantum number n is used to show the energy of each shell
- electrons will occupy the lowest energy level shell first and fill the rest
  - this is known as the ground state of the electron
  - it is the most stable state of the electron because it occupies the lowest energy level
  - BUT sometimes it can gain a higher energy state, it is called an excited electron then
- energy of sub-shell depends on the azimuthal quantum number l, it also denotes the shape of the orbital
  - values of l are $n-1$, e.g, s shell has energy level of 1, and p has energy level of 2, and so on
  - order of energy of sub-shells is $n+l$
  - $1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p$ and so on
  - $4s$ has lower energy than $3d$ because $4s = 4 + 0(n+l)$ while

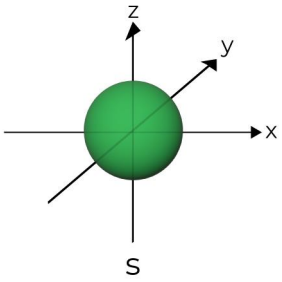
    $3d = 3 + 2(n+l)$



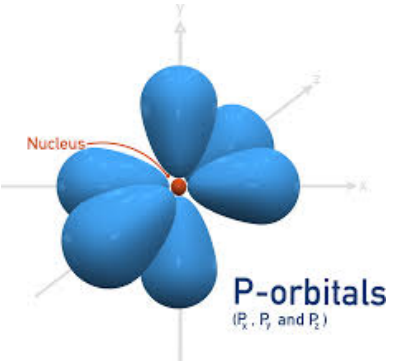
Main shell	Sub-shell	Max number of sub-shells	Max number of electrons in sub-shell	Max number of electrons in main shell
1	s	1	2	2
2	s p	1 3	2 6	8
3	s p d	1 3 5	2 6 10	18
4	s p d f	1 3 5 7	2 6 10 14	32

Orbitals

- it is impossible to know the exact location of an electron at a given time
- but it is possible to find the most probable position of an electron
- this probable position is the orbital
- s, p, d, and f shells have different shape orbitals



Shape of s-orbital

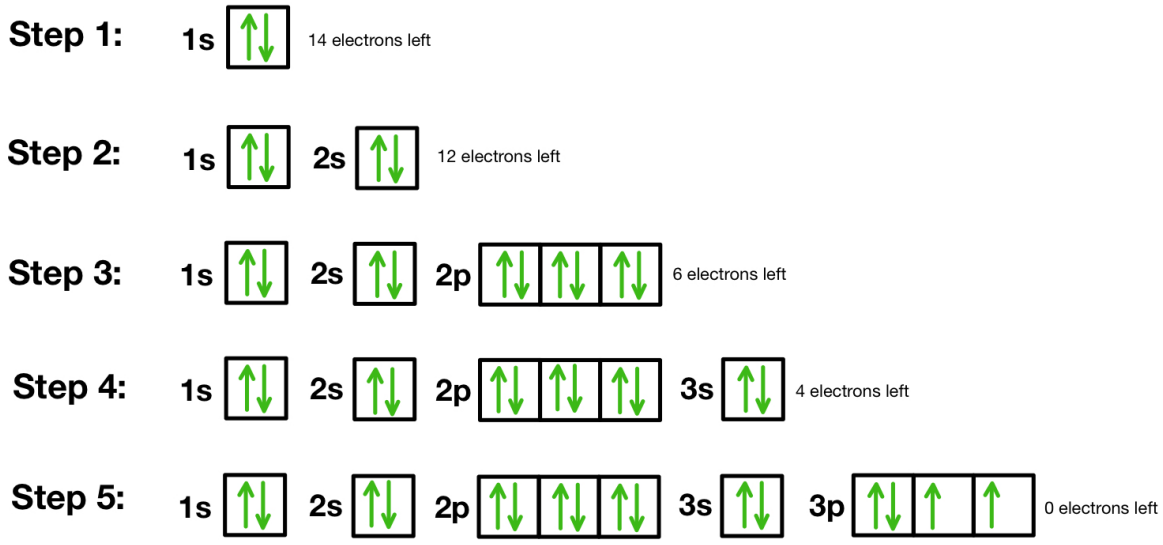


- each orbital can hold 2 electrons that flow in the opposite direction
- orbitals with the lowest energy will be filled first

Electronic configuration of electrons

- to write this, just write sub-shell to sub-shell
  - e.g, magnesium - $1s^2\ 2s^2\ 2p^6\ 3s^2$
- noble gas configuration can also be used, magnesium - $[Ne]\ 3s^2$
- some atoms will have sub-shells half-filled for stability stakes
  - e.g, $Cu - 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^{10}$
  - sub-shells that are half-filled or full are more stable than other configurations, so the $4s$ shell gives one electron to the $3d$ shell

    - only possible in the outermost shell and the shell next to it
- a **spin diagram** or boxes can also be used



- here we can see electrons will go to a new orbital as a single electron than become a paired orbital when there's no more space
- this is because electrons are negatively charged and repel each other

Electronic configuration of ions

- same as in electron configuration, but you add or remove the outermost electron
    - e.g, $Na - 1s^2\ 2s^2\ 2p^6\ 3s^1$, $Na^+ - 1s^2\ 2s^2\ 2p^6$