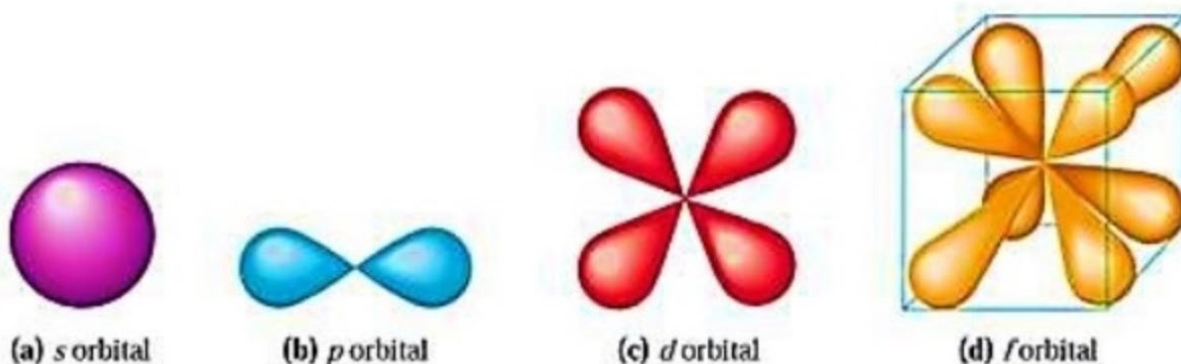
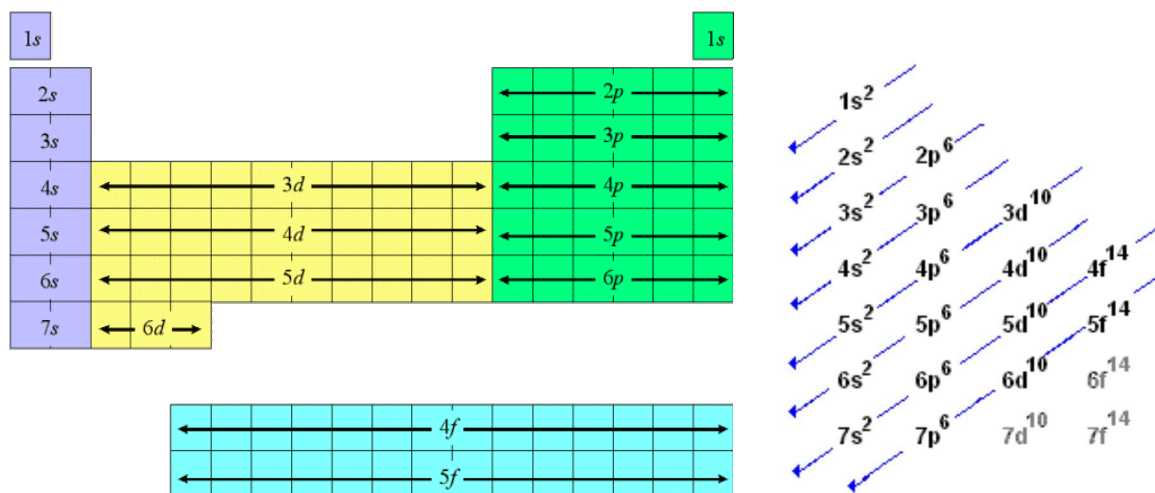


Orbitals: What are they and how do they work?

While it is common for electrons to be displayed as concentric rings around the nucleus, they are actually arrayed in a three-dimensional series of orbitals that are either type s, p, d, or f



Electrons can be thought of as “filling in” the smallest orbitals towards the outermost, with the final electrons to be filled in being the valence electrons. These orbitals effectively stack on top of one another in layers as more electrons are added. Hydrogen has a single electron in the 1s orbital ($1s^1$), whereas Helium has two electrons in the 1s orbital ($1s^2$). The pattern that this process follows is shown below. Both images are effectively displaying the same information, but in different patterns. Hint hint: The diagram on the right is easy to draw from memory for a test



S Orbitals can carry 2 electrons, p can carry 6, d can carry 10, and f can carry 14.

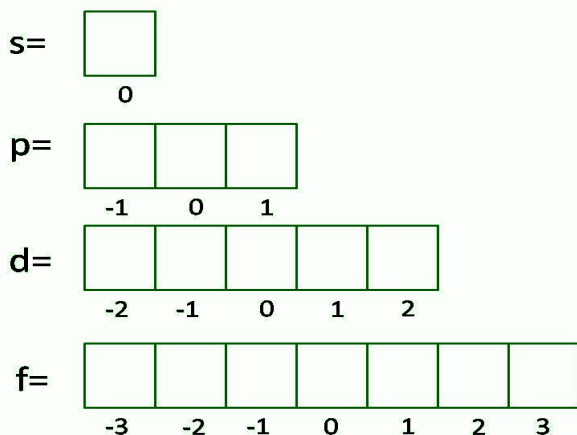
Quantum Numbers

Each and every electron that is found in any orbital has a unique quantum number, like the electron's home address. It lists the layer of the orbital group, or how many orbital groups from the nucleus it is; it lists the type of orbital the electron is found in; it lists the location within the orbital that the electron can share with another electron, and finally it lists the spin of the electron, which denotes it from the electron it is paired with.

Principal Quantum Number (n) - describes the size/layer of the orbital. They are represented by discrete integers, where the larger value represents a larger orbital. The leading number in the abbreviation ($3d^2$, for instance) is the n value.

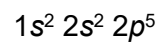
Angular Quantum Number (l) - represents the shape of the orbital, s p d or f. They are once again discrete integers between 0 and 3. $s = 0$, $p = 1$, $d = 2$, $f = 3$.

Magnetic Quantum Number (m) - indicates the subset of the orbital that an electron is found in. It is represented as a range of integers between -l and l. For instance, if a p orbital is used, $l = 1$ and m can equal -1, 0, or 1. This is often represented in the form of a box diagram seen below.



Electron Spin (\uparrow) - Electrons spin in opposing directions, semantics dictate clockwise/counterclockwise or up/down. When listing the quantum number, this is represented as $+\frac{1}{2}$ or $-\frac{1}{2}$.

Electrons fill sub orbitals separately from one another until no sub orbitals are available, at which point they pair up with electrons of opposing spin. In an m box diagram, this is represented by filling in up arrows followed by down arrows.



In the example above, Fluorine (F) has the -1 and 0 sub orbitals filled, with an unpaired electron in the $m = +1$ sub orbital. From previous chemistry work, we know Fluorine forms an anion with a charge of -1 due to an unpaired electron, and unpaired electrons are the basis for chemical reactions.