QUANTUM NUMBERS/ELECTRON ADDRESSES IN SPACE

Principle quantum number (n) – "n" represents the specific energy level (shell) for the particular electron of concern. The principle quantum number has rough correspondence to the row number in the Periodic Table. It is very reliable for "s" and "p" electrons: the first two columns on the left of the table (columns 1 and 2) and the last six columns on the right of the table (columns 13-18). There is some confusion when it comes to those elements found in the middle of the table, columns 3-12. Electrons added to these elements are really being added to the "d" sub shell of the previous energy level (e.g., row 4, columns 3-12 are really electrons that are designated n=3). This seems simple enough but this is also not a hard and fast rule. Electrons being added to columns 11 and 12 are really being added into n=4. We run into similar problems when discussing the lanthanide and actinide series of elements. These are two levels removed in terms of their energy sub shells. Thus, while barium adds electrons into n=6, lanthanum is adding an electron into n=4. In lanthanum, this is the first 4f electron. The entire lanthanide series is adding electrons into the 4f energy sub shell, while the actinide series is adding electrons into the 5f energy sub shell.

Second quantum number (ℓ) – "ℓ" represents the shape of the sub shell and repeats itself throughout the Periodic Table. The various shaped sub shells have the following designations: s = 0, p = 1, d = 2 and f = 3. So, any element found in columns 1 or 2 will have a second quantum number of "$\ell = 0$", any element found in columns 13-18 will have a second quantum number of "$\ell = 1$", any element found in the center of the Periodic Table (columns 3-12) would have a second quantum number of "$\ell = 2$" and finally those two rows of elements found at the very bottom of the Periodic Table would have a second quantum number of "$\ell = 3$". As usual, it's not quite this simple. What about those elements found in columns 11 and 12? These are really electrons being added to an "s" sub shell. So, these electrons really should have an "$\ell = 0$" second quantum number but we always show them as "$\ell = 2$".

Third quantum number (m) – The third quantum number (m) represents the number of locations within an energy sub shell that can house a pair of electrons. It is designated by –1, 0 and +1. "s" sub shells have but a single location ($\ell = 0$) so the third quantum number for these electrons is "m = 0". "p" sub shell electrons, on the other hand, can be found in three locations, along the x, y and z-axes. These would then have third quantum numbers of m = -1, m = 0 and m = +1. By convention, these represent the p_x, p_y and p_z orbitals within the "p" sub shell. There are five possible locations for "d" orbital electrons within the "d" sub shell. So, the possible third quantum numbers are: -2, -1, 0, +1 and +2.

Fourth quantum number (s) – The fourth quantum number (s) represents the spin of an electron as it is added into an orbital. Electrons added into orbitals follow Hund's Rule: Electrons are added one at a time into the orbitals at the lowest available energy level until each of the orbitals contains a single electron and only then can a second electron be paired into the orbital. By convention, these first electrons are given a fourth quantum number of m = +1/2. The pairing of electrons begins after each orbital is filled and these "pairing " electrons are given the opposite spin designation of m = -1/2. Thus, in filling a "p" sub shell with electrons, the first three electrons would be filling, one at a time, the three "p" orbitals, with an "m" value of –1, 0 and +1 respectively, with an "s" value of +1/2 for each. The next three electrons are added into the "p" orbitals again with "m" values of –1, 0 and +1 respectively, but with an "s" value of –1/2 for each.