QUANTUM NUMBERS

This initial discussion of quantum numbers isn't going to go down very well. It's very foreign to think of things this way It will seem made-up and artificial. Rest assured that quantum numbers are a direct result of the kinds of solutions that come out of the Schrödinger equation. Work through it. By the time we're done, it will make better sense.

The first quantum number, the **principal quantum number**, is called **n**. It labels the energy level of an electron. In the H-atom energy level diagram above, you can see that the levels are labeled from lowest to highest, starting at n=1. We usually say that n labels which **shell** that the electron occupies. Inner shells are small and closer to the nucleus, and outer shells are larger. Inner shells are of lower energy, outer shells of higher energy.

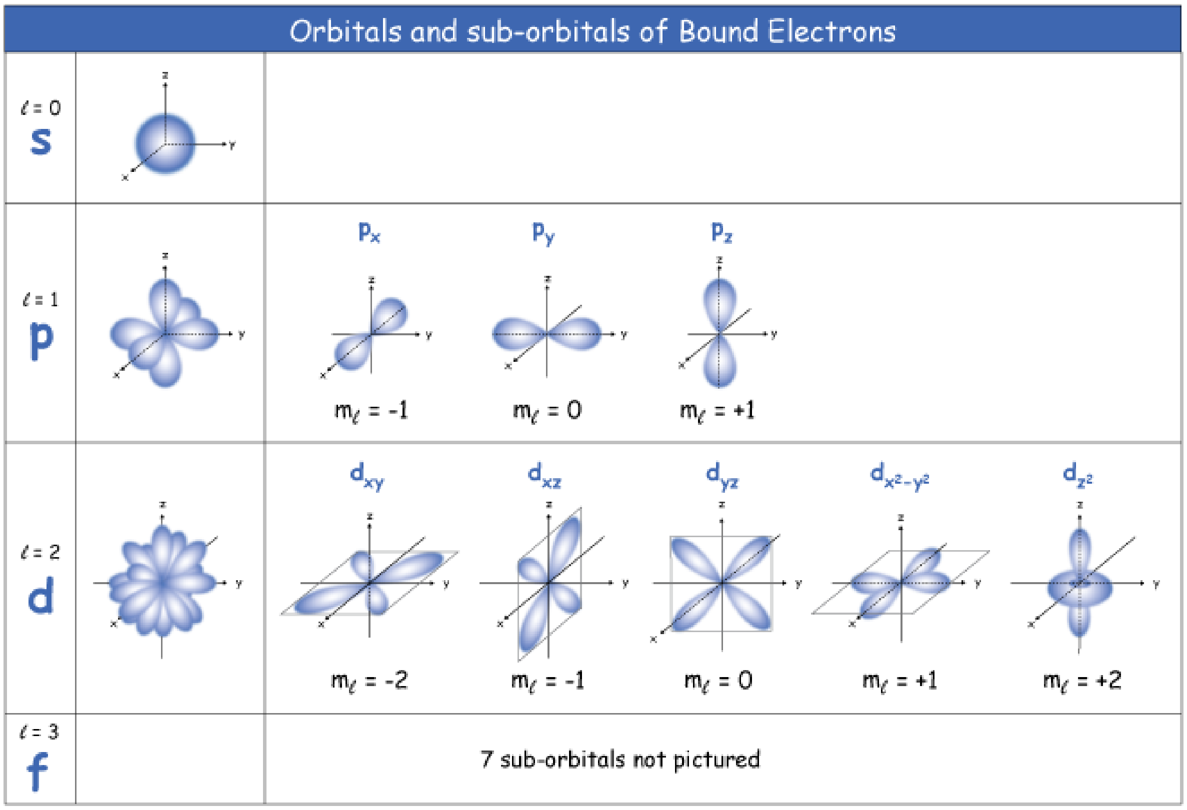
The second quantum number is **L**, the **azimuthal quantum number**. It describes the general shape of the **orbital** occupied (created, actually) by an electron. The shape comes from the 3-D shape of the spherical harmonic functions. L runs from 0 to n-1, so for n = 1, L can only be zero, but for n = 2, L = 0 or 1, and so on.

It is an artifact of the development of the quantum theory that we call L=0 orbitals **s-orbitals**, and for L=1,2,3 we call them **p**, **d** and **f**, respectively. P, d and f orbitals are composed of several **sub-orbitals**. These rules seem strange, but trust me, they pop right out of the mathematics.

The third quantum number is $\mathbf{m_L}$, the **magnetic quantum number**. It labels the sub-orbitals within a p, d or f orbital. The values of m depend on L. If L = 0, then m = 0; if L = 1, then m_L = -1, 0, 1; if L = 2, then m_L = -2, -1, 0, 1, 2; and so on, or m_L = -L, -L+1, ... , L-1, L.

The final quantum number is the **spin quantum number**, which we have met before in the SG experiments. It is usually called $\mathbf{m_s}$, and takes on the values ± 1/2. In the world of subatomic particles, there are particles with "half-integer spin" (Fermions) like 1/2, 3/2, and with "integer spin" (Bosons), like 1, 2, ... Electrons are Fermions.

Below is a chart of the s, p, and d orbital shapes.



Source: http://www.drcruzan.com/Chemistry_Electrons.html