Atoms and electrons: Quantum Numbers: Student Review Notes

Quantum Numbers

Each electron has a set of 4 quantum numbers that fixes its energy and the associated orbital

1. **Principle quantum number, n**, gives the primary energy level n = 1, 2, 3, 4, 5, 6, 7.
2. **Angular momentum quantum number, l** gives the sublevel (s, p, d, f stuff) l = 0, 1, 2, 3,...n-1
   0 refers to an s-sublevel
   1 refers to an p-sublevel
   2 refers to an d-sublevel
   3 refers to an f-sublevel
   } The letter designations have a historical context. They describe the spectral line relating to transitions involving these levels; eg, "s" denotes a "sharp" line.
3. **Magnetic quantum number, m_l** gives the orientation of the subshell (orbital) m_l = -l,...0...,+l. (This gives each orbital a unique name). Like, the three orbitals on a p-sublevel would be named -1, 0 and 1.
4. **Magnetic spin quantum number, m_s** , This differentiates the two electrons that can exist in a single orbital. ms = +1/2 (spin up) or -1/2 (spin down).

The **Pauli Exclusion Principle** says that no two electrons on an atom can have the same 4 quantum numbers. What this says is that you can only have 2 electrons in an orbital since m_s only has two possible values and therefore, if an orbital is doubly occupied, the electrons must have opposite spins.

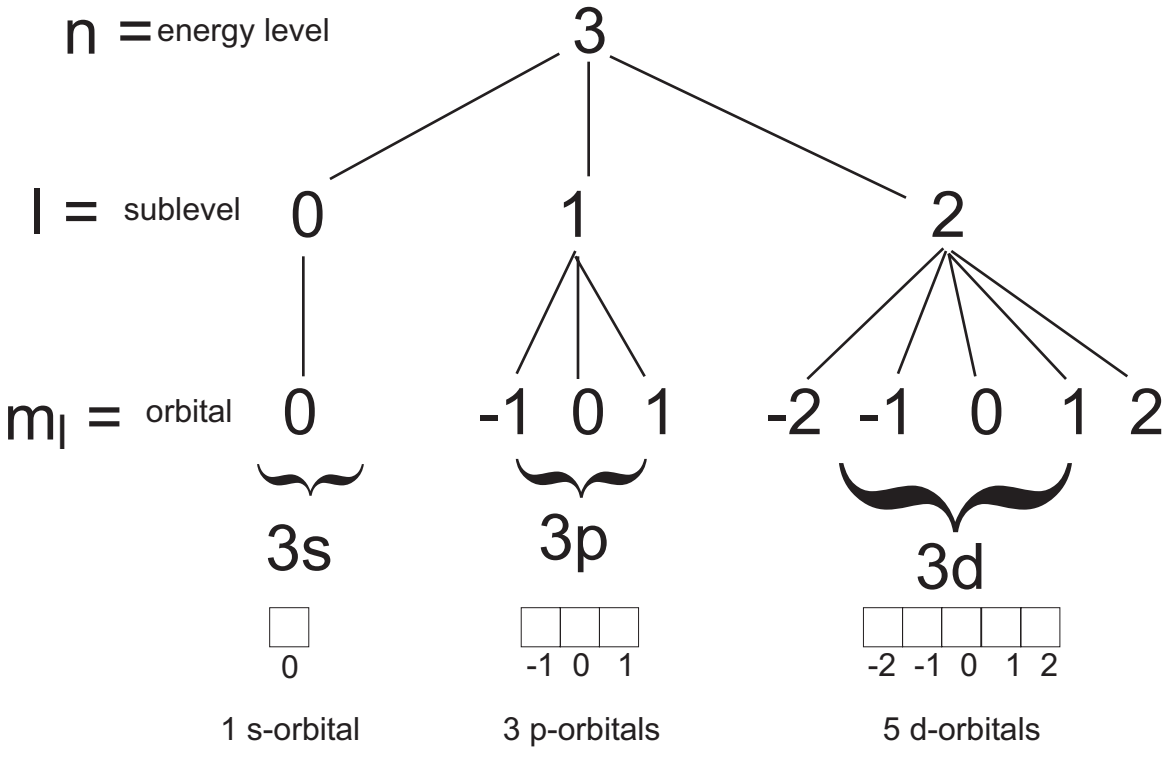
What are the possible quantum numbers for this electron?

$1s^2 2s^2 2p^1$

{ 2,1,-1,1/2 2,1,-1,-1/2 2,1,0,1/2 2,1,0,-1/2 2,1,1,1/2 2,1,1,-1/2 } All these are possible. Orbitals are degenerate, i.e. they have the same energy.

You need to understand the overlap between aufbau notation and quantum numbers

Take a look at the third energy level:



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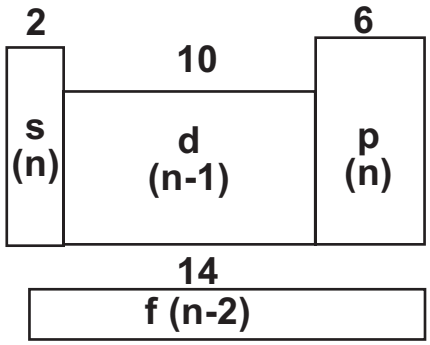
Electronic Configuration: This gives the number of electrons in each principle energy level and sublevel. This is where you use the aufbau principle (s,p,d,f stuff).

Orbital Diagrams: This is a diagram that shows electrons in each orbital with the additional information of the spin of the electron (arrow up for positive spin and arrow down for negative spin).

Quantum Numbers: These are the set of 4 numbers, n, l, m_l, m_s propsed by Planck that uniquely describe the energy of an electron.



Understand This!

Orbital Shapes

These are solutions to Schrodinger's equation and represent the space in which electrons reside for a given set of 4 quantum numbers

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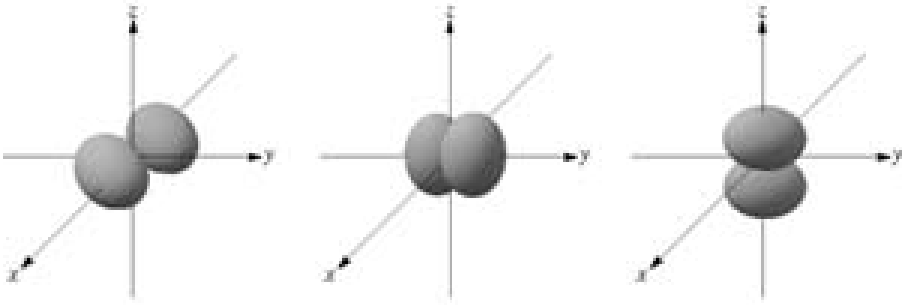
s-sublevel

An s-sublevel is denoted by the quantum number l = 0. It contains 1 orbital that is labeled with the quantum number m_l = 0.

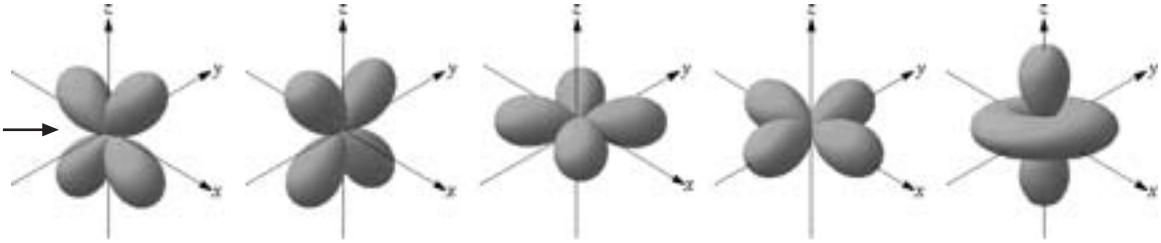
p-sublevel

A p-sublevel is denoted by the quantum number l = 1. It contains 3 orbitals that are labeled with the quantum number m_l = -1,0,1.



d-sublevel

A d-sublevel is denoted by the quantum number l = 2. It contains 5 orbitals that are labeled with the quantum number m_l = -2,-1,0,1,2.



f-sublevel

An f-sublevel is denoted by the quantum number l = 3. It contains 7 orbitals that are labeled with the quantum number m_l = -3,-2,-1,0,1,2,3.