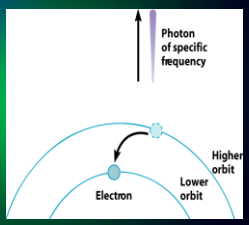
Orbitals and Electron Configurations

Bohr's theory

Three rules:

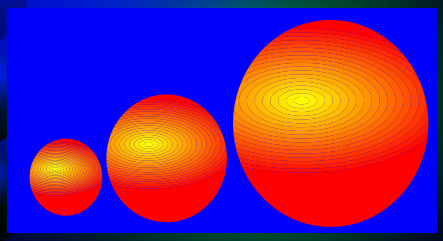
- Electrons only exist in certain allowed **orbitals**
- Within an **orbital**, the electron does not radiate
- Radiation is emitted or absorbed when changing orbitals



Orbitals are math functions

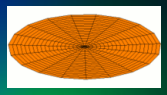
- An **atomic orbital** is a mathematical function that describes the wave-like behavior of either one electron or a pair of electrons in an atom.
- This function can be used to calculate the probability of finding any electron of an atom in any specific region around the atom's nucleus.
- These functions may serve as three-dimensional graphs of an electron's likely location.
  - The term may refer directly to the physical region defined by the function where the electron is likely to be.
  - Atomic orbitals are the possible quantum states of an individual electron in the collection of electrons around a single atom, as described by the orbital function.

S orbitals

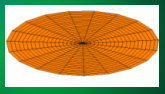


s-type modes

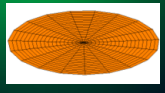
Mode (1s orbital)



Mode (2s orbital)

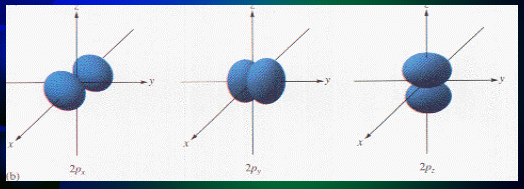


Mode (3s orbital)

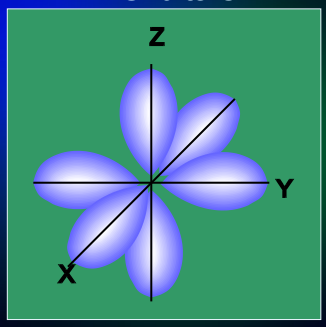


http://en.wikipedia.org/wiki/Atomic_orbital#Orbital_names

P orbitals

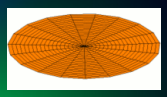


P Orbitals

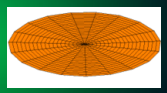


p-type modes

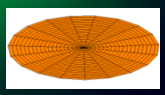
Mode (2p orbital)



Mode (3p orbital)

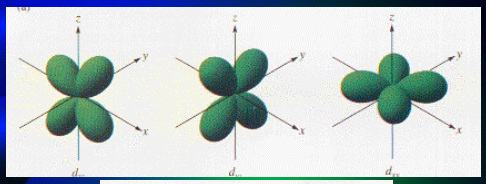


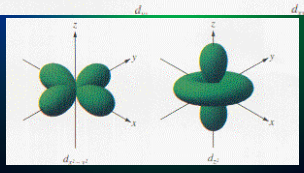
Mode (4p orbital)



http://en.wikipedia.org/wiki/Atomic_orbital#Orbital_names

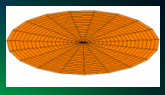
D orbitals



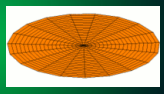


d-type modes

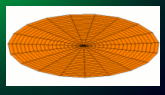
Mode (3d orbital)



Mode (4d orbital)

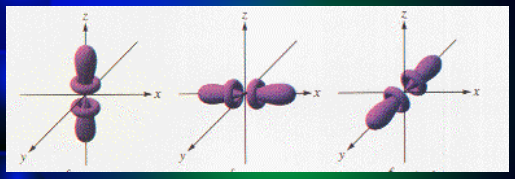


Mode (5d orbital)

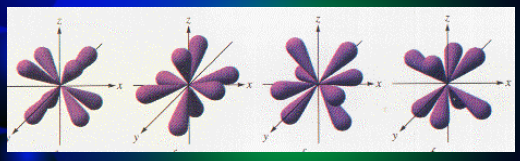


http://en.wikipedia.org/wiki/Atomic_orbital#Orbital_names

F orbitals



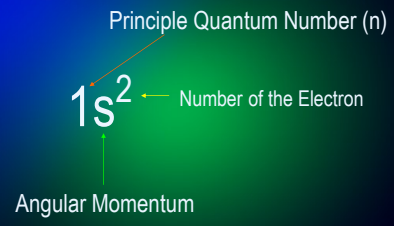
F orbitals



Electron Configuration

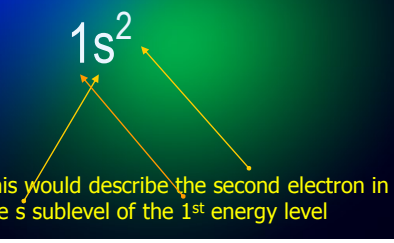
- Expressing the electron configuration of an atom or ion at the atomic level is the universal language of chemistry.
- The configuration is described by 4 quantum numbers. Just like a point can be described by the (x,y) coordinates, an electron can be described by 4 quantum numbers.

Notation for Quantum Numbers



The fourth quantum number with two possible values was added *ad hoc* to resolve experimental conflicts; this supposition could later be explained in detail by relativistic quantum mechanics and from the results of the renowned Stern-Gerlach experiment.

In other words



Electron Configuration and Electron Shell

- Rules for the placement of electrons in orbitals (electron configuration).

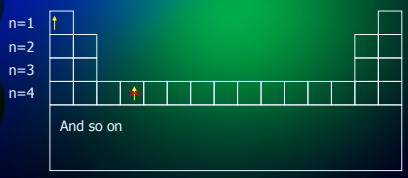
1. **The Pauli Exclusion Principle:** No two electrons in an atom may have the same set of values of quantum numbers.

2. **Hund's Rule:** When electrons occupy orbitals of equal energy, one electron enters each orbital until all the orbitals contain one electron. Only after all the orbitals are filled, will electrons pair-up. This applies to the p, d and f sublevels.

3. Quantum numbers include the three that define orbitals, as well as s, or spin quantum number.
   - Two electrons may occupy a single orbital, so long as they have different values of s.
   - Only two electrons, because of their spin, can be associated with each orbital.

Hund's rule

electrons enter orbitals of lowest energy first.



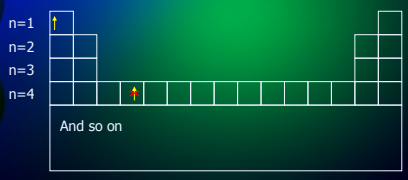
What does that mean?

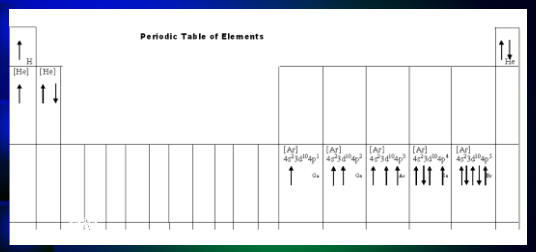
Look at your periodic table.

Along the left side you will see numbers from 1 to 7.

These represent the energy levels of electrons for that row of atoms. n=1, n=2 , n=3 …

Electrons enter orbitals of lowest energy first.





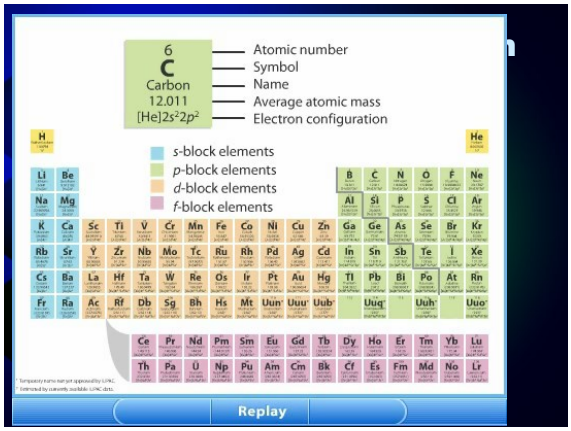
Bohr was the first to propose t these electron configuration as the basis for the periodicity of the Table of Elements

```
1s
2s                        2p  2p  2p
3s                        3p  3p  3p
4s        3d  3d  3d  3d  3d  4p  4p  4p
5s        4d  4d  4d  4d  4d  5p  5p  5p
6s  (4f)  5d  5d  5d  5d  5d  6p  6p  6p
7s  (5f)  6d  6d  6d  6d  6d  7p  7p  7p
```

Electron Configurations

H							He
$1s^1$							$1s^2$
Li	Be	B	C	N	O	F	Ne
$1s^2 2s^1$	$1s^2 2s^2$	$1s^2 2s^2 p^1$	$1s^2 2s^2 p^2$	$1s^2 2s^2 p^3$	$1s^2 2s^2 p^4$	$1s^2 2s^2 p^5$	$1s^2 2s^2 p^6$

1s																	1s
2s	2s																2p
3s	3s																3p
4s	4s						3d	3d	3d	3d	3d	4p					4p
5s	5s						4d	4d	4d	4d	4d	5p					5p
6s	6s	(4f)	5d	5d	5d	5d	5d	6p									6p
7s	7s	(5f)	6d	6d	6d	6d	6d	7p									7p



Electron Configurations using Noble Gas Notation

H $1s^1$

He $1s^2$ [He]

Li [He] $2s^1$

Mg [He] $2s^2$

B [He] $2s^2 p^1$

Si [He] $2s^2 p^2$

Ne $1s^2 2s^2 p^6$ [Ne]

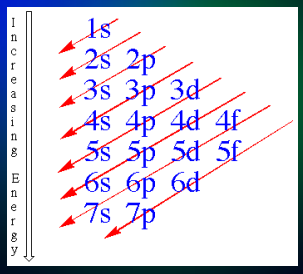
Na $1s^2 2s^2 p^6 3s^1$

Ca [Ne] $3s^2$

Al [Ne] $3s^2 p^1$

THE ULTIMATE TOOL

(draw in the reference section your notebook)



THE TOOL

- Remember to start at the beginning of each arrow, and then follow it all of the way to the end, filling in the sublevels that it passes through. In other words, the order for filling in the sublevels becomes; 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d,7p.

Practice

- In your notebooks
- Make sure it is in your 'Table of Contents'
- Write the electron configurations for elements 1-20