Electron Configuration

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d,

5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p

Electron Configuration

$\boxed{1}\boxed{s}^{\boxed{1}}$

row #
shell #
possibilities are 1-7
7 rows

subshell
possibilities are
s, p, d, or f
4 subshells

group #
valence e-
possibilities are:
s: 1 or 2
p: 1-6
d: 1-10
f: 1-14
Total e- should equal
Atomic #

What element has an electron configuration of $1s^1$?

Practice:

Ask these questions every time you have to write an electron configuration

- Lithium:
  1. find the element on the periodic table atomic # = 3
  2. what is the period number? 2
  3. how many shells? 2
  4. what is the group number? 1
  5. how many valence electrons? 1
  6. what subshell(s) does Li have? s
  7. what is the electron configuration? $1s^2\ 2s^1$

Practice:

Ask these questions every time you have to write an electron configuration

- Boron:
  1. find the element on the periodic table atomic # = 5
  2. what is the row #? 2
  3. how many shells? 2
  4. what is the group #? 3
  5. how many valence electrons? 3
  6. what subshell(s) does B have? p
  7. what is the electron configuration? $1s^2\ 2s^2\ 2p^1$

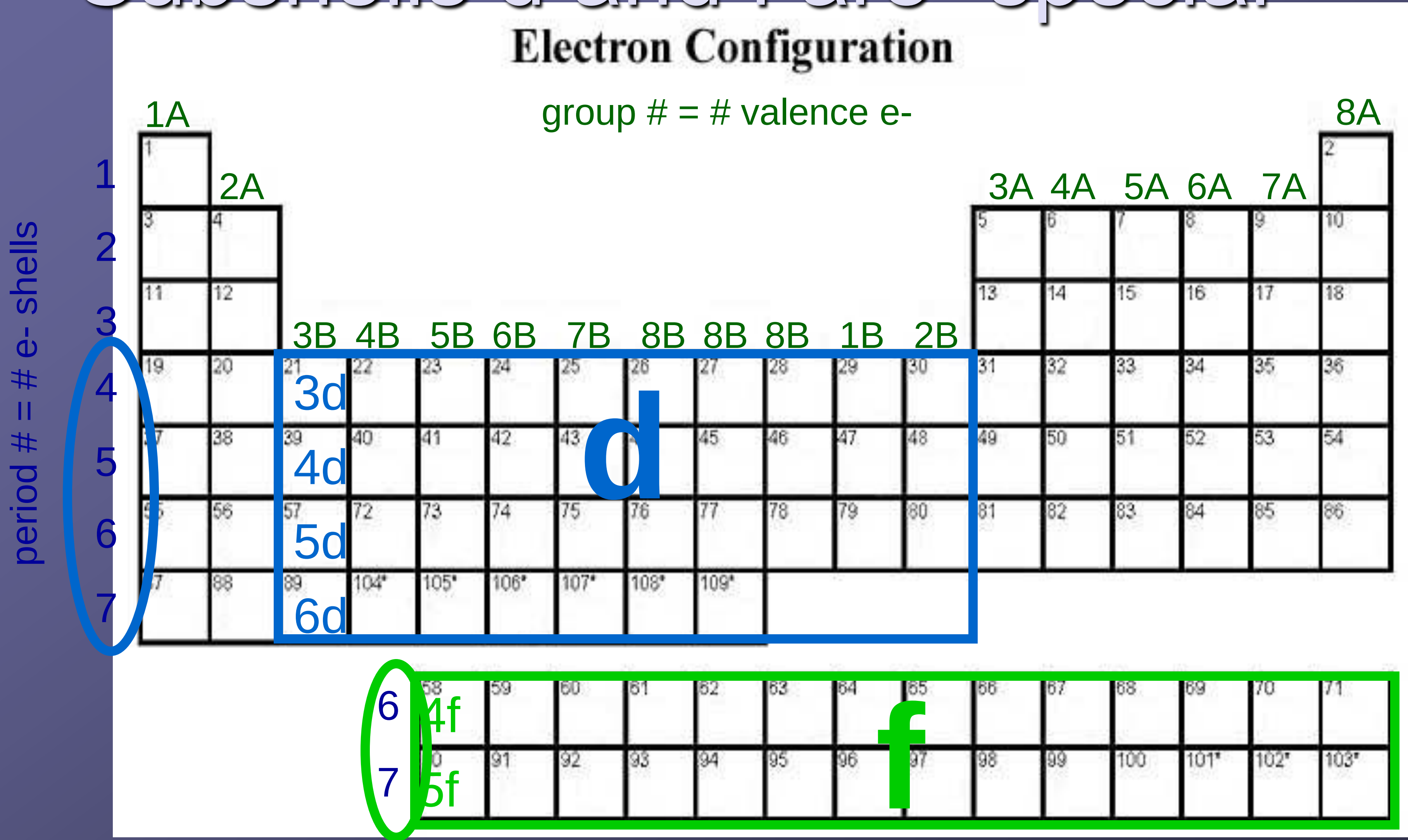
Order of Electron Subshell Filling:

It does not go "in order"

$1s^2$			
$2s^2$	$2p^6$		
$3s^2$	$3p^6$	$3d^{10}$	
$4s^2$	$4p^6$	$4d^{10}$	$4f^{14}$
$5s^2$	$5p^6$	$5d^{10}$	$5f^{14}$
$6s^2$	$6p^6$	$6d^{10}$	
$7s^2$	$7p^6$		

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^6 7s^2 5f^{14} 6d^{10} 7p^6$

Subshells d and f are “special”



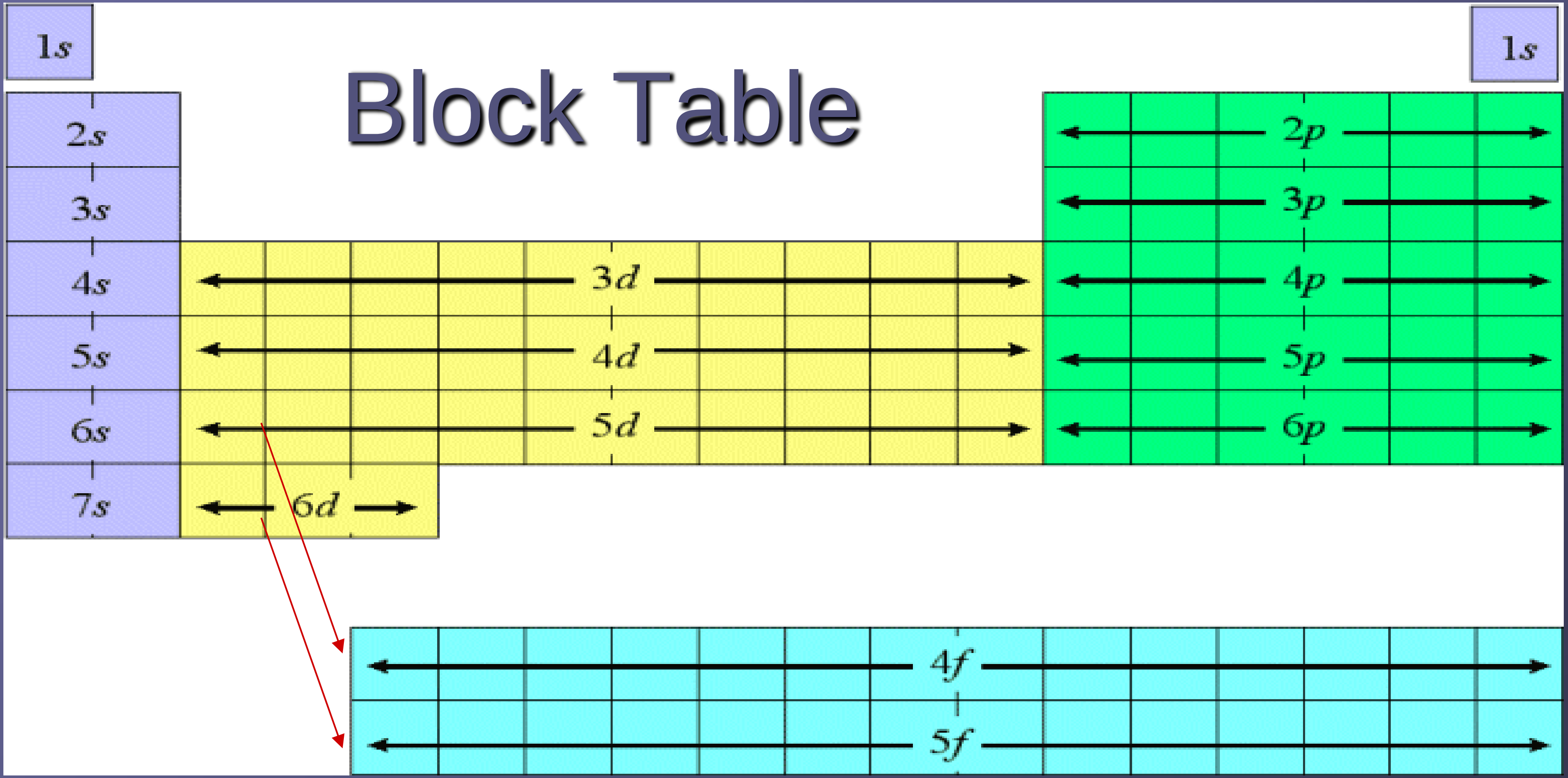
s, p, d, and f

- The different sections of the Periodic Table are very important in understanding Electron Configuration.
- There are 4 “Blocks” in the Periodic Table:
  - the s-block, p-block, d-block, & f-block.
- Remember the special rules for the d- and f- blocks:
  - d – n-1
  - f – n - 2

What do s, p, d, and f mean?

- These refer to the **sublevels** within the principal quantum level (n).
- So, for n = 1, there is only one sublevel, s.
- n = 2, there are 2 sublevels: s & p
- n = 3, there are 3 sublevels: s, p, & d
- So, within each level, there are n sublevels.

Block Table



- This shows the different blocks in the Periodic Table.
- It also shows in what order to write electron configurations (1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d,7p)

An Example

- As - Arsenic

- $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^3$
- The first number is which row it's in, or the *principal quantum number (energy level)*
- The character is the block its in, which refers to the *sublevel*
- The superscript is the total number of electrons in the *sublevel*

The Diagonal Rule

A shortcut!

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

Do not exist in normal ground state atoms

d^4 and d^9 rules

- Sometimes an electron configuration will end with 4 or 9 electrons in the d-sublevel; these are unstable
- Will steal electrons from the s-sublevel before it to stabilize. Ex. Chromium:
- $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4 \rightarrow$
  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$

d^4 and d^9 rules

- Ex. 2; Silver
- $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4 4p^6 5s^2 4d^9 \rightarrow$ $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4 4p^6 5s^1 4d^{10}$

The Noble Gas Configuration

An obvious solution and convenient short cut!

Noble Gas Configuration

- The Noble Gases are:
  - He, Ne, Ar, Kr, Xe, Rn
- Notice that each noble gas finishes a row, or energy level.
- Noble gas configurations take advantage of this by condensing what you have to write:
  - Ex. He : $1s^2$
  - Ex. C : $1s^2$ $2s^2$ 2p2
    - Noble Gas Configuration for C: [He] $2s^2$ 2p2

Noble Gas Config. – an example

- The normal configuration for As-(Arsenic)
  - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^3$
- Notice, the part in yellow is the same as Argon's configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
- The noble gas configuration will start with the gas in the row before it.
  - $[Ar]\ 4s^2\ 3d^{10}\ 4p^3$
- It cuts down on a lot of writing, and that's a good thing.

Orbital Diagrams

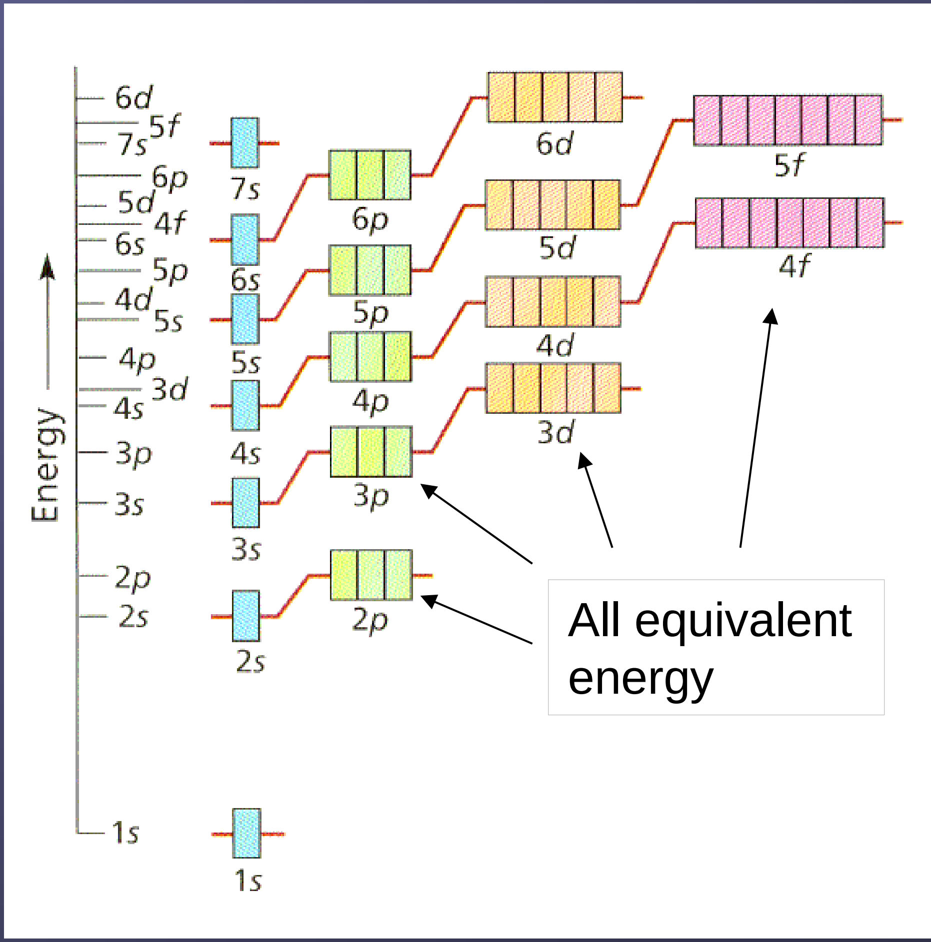
They’re Useful!

Orbitals

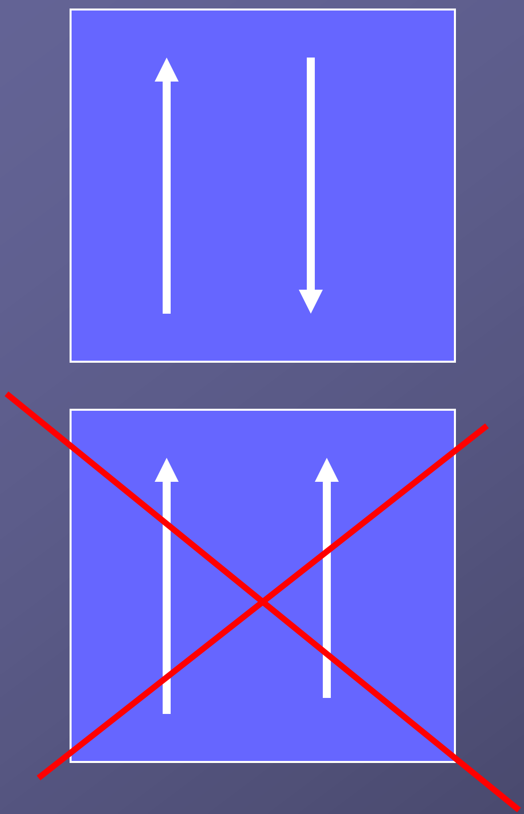
- Orbitals
  - Each sublevel (s, p, d, f) contains orbitals.
  - Remember, orbitals are electron-clouds that hold the electrons 90% of the time.
  - Each orbital can hold TWO electrons, so
    - s - 2 electrons, 1 orbital
    - p – 6 electrons, 3 orbitals
    - d – 10 electrons, 5 orbitals
    - f – 14 electrons, 7 orbitals

The Aufbau Principle

- Each electron occupies the lowest energy orbital
  - Electrons are Lazy!!!
- All orbitals related to an energy level are of equal energy.
  - Ex. The three 2p orbitals are the same energy level.



Pauli Exclusion Principle



Box = orbital

Arrow = electron

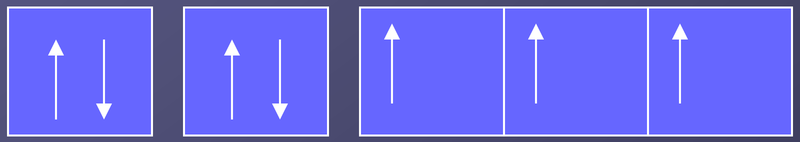
- A maximum of two electrons may occupy a single orbital, but *only if the electrons have opposite spins.*
  - Spin -- Electrons has an associated “spin,” either one way or the other, like a top.
  - These spins are called “spin up” and “spin down.”
  - See example on board.

Hund's Rule

- **Single electrons with the *same* spin must occupy each equal-energy orbital *before* additional electrons with opposite spins can occupy the *same* orbitals.**
  - Electrons are **UNFRIENDLY**
  - Why?

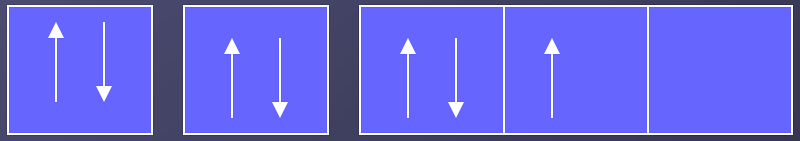
Ex. Nitrogen:

•$1s^2\ 2s^2\ 2p^3$



$1s^2$ $2s^2$ $2p^3$

NOT



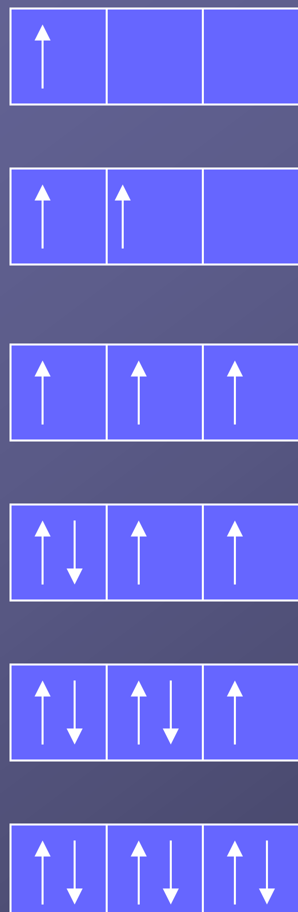
$1s^2$ $2s^2$ $2p^3$

Quantum Numbers

- **Principal quantum number (*n*)** - describes the **SIZE** of the orbital or **ENERGY LEVEL** of the atom.
- **Angular quantum number (*l*) or sublevels** - describes the **SHAPE** of the orbital.
- **Magnetic quantum number (*m*)** - describes an **orbital**'s **ORIENTATION** in space.
- **Spin quantum number (*s*)** - describes the **SPIN** or direction (clockwise or counter-clockwise) in which an electron spins.

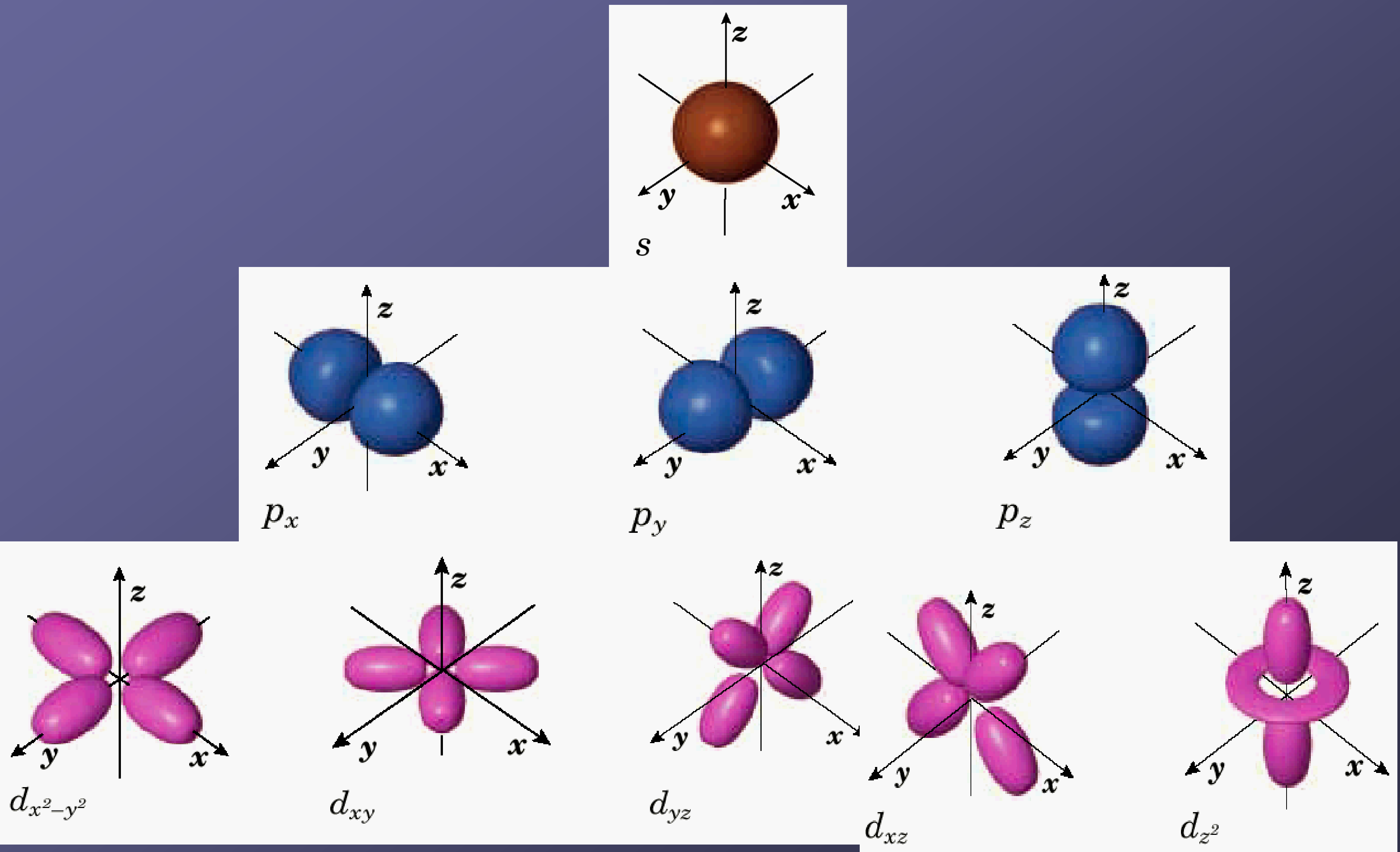
The order of Things…

- Np^1
- Np^2
- Np^3
- Np^4
- Np^5
- Np^6



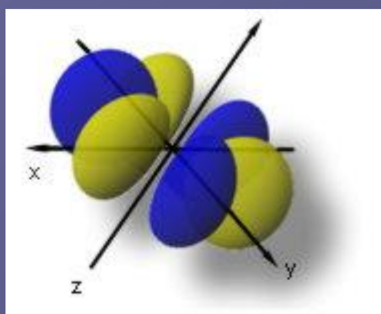
- Electrons, being unfriendly, fill up the empty orbitals before sharing orbitals.
  - Similar to seats on a bus – on a bus, you sit alone, rather than with a stranger, if there is an option.

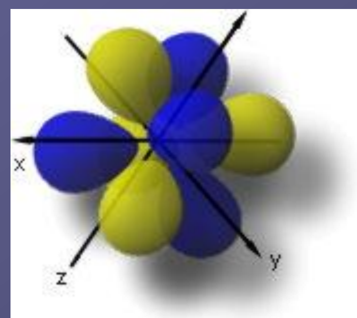
The Shapes of the s, p, and d Orbitals

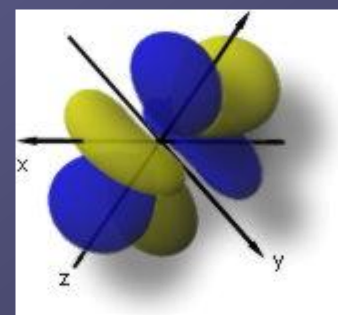


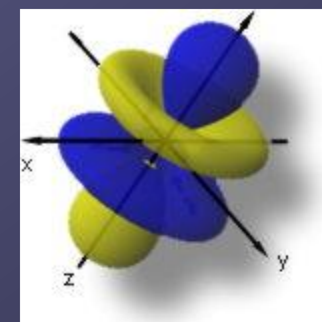
F-Orbitals!

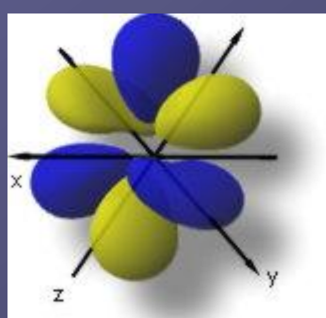
- Do not bother sketching these—just notice how STRANGE they are!

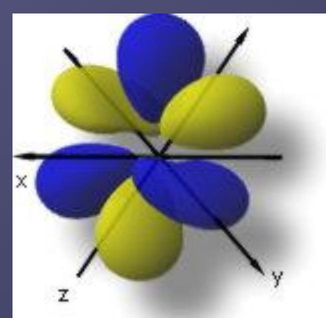


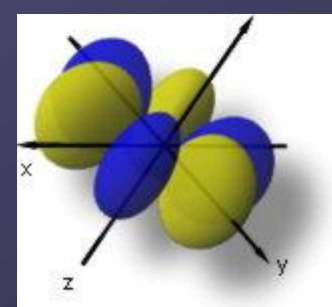


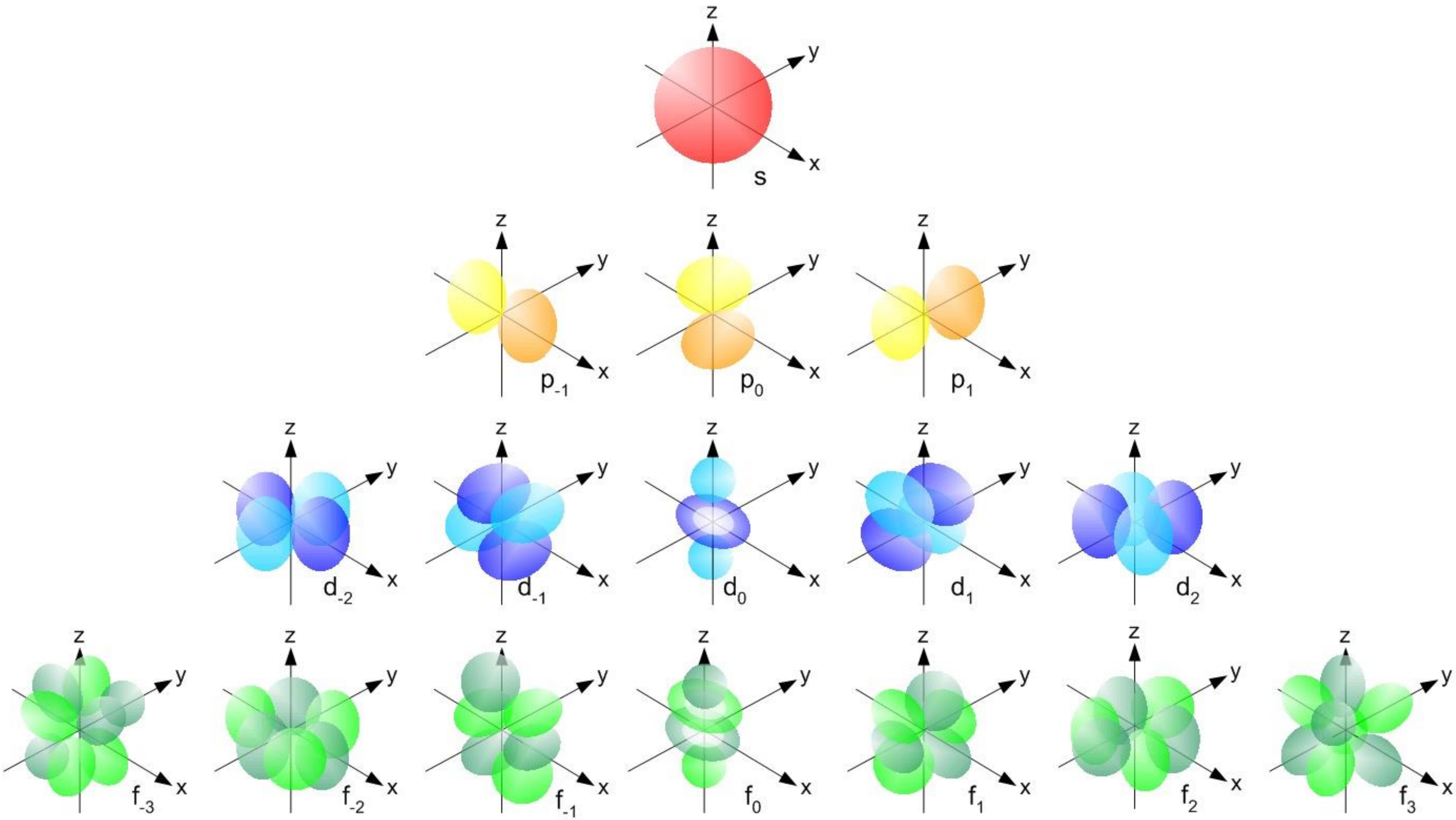











s
p-1
p0
p1
d-2
d-1
d0
d1
d2
f-3
f-2
f-1
f0
f1
f2
f3
x
y
z

Orbital	Shape	No. per sublevel
s	Spherical	1
p	Figure-8, dumbbells	3
d	Double figure-8s & drops with coffee	5
f	Don't worry!	7

e^- Config. and Orb. Diag. for Ions

- What is an ion?
- Examples of ions:
  - Na^+
  - Mg^{2+}
  - Fe^{3+}
  - Cl^-
  - S^{2-}

- When writing electron configurations or orbital diagrams for ions it's a little harder because it can look like a different atom.
- Just subtract the missing electrons or add the extra electrons