

# Electrons in Atoms

Packet #11



# ATOMIC MODELS



# Atomic Models

- Students are to investigate the history of atomic models on their own.



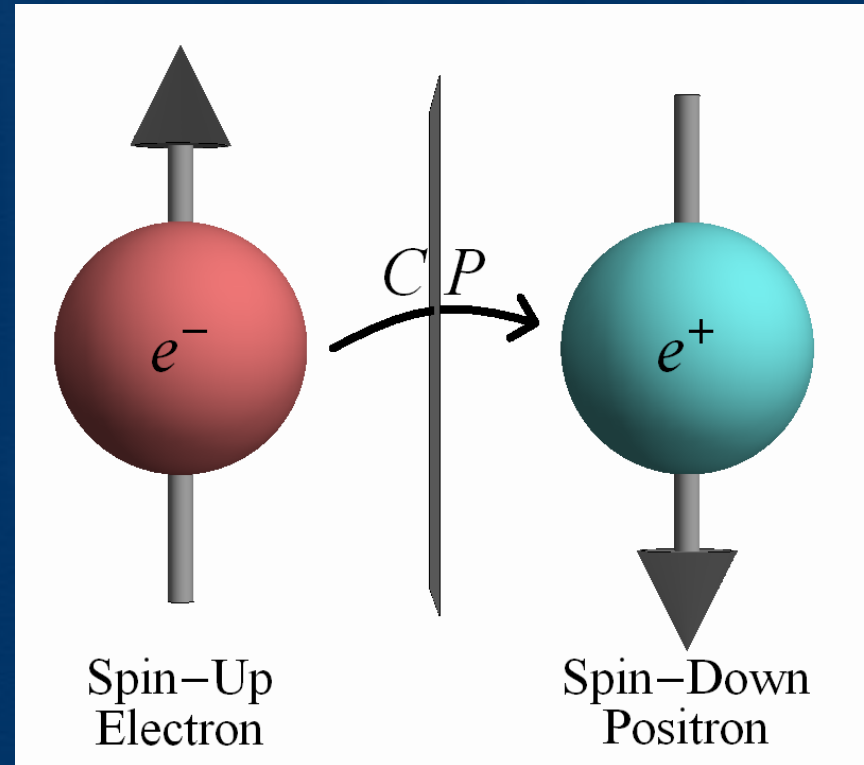


# ELECTRONS

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# Where Electrons Spin

- Electrons spin in two places around the atom
  - Shells
  - Orbitals
    - Orbitals make up shells



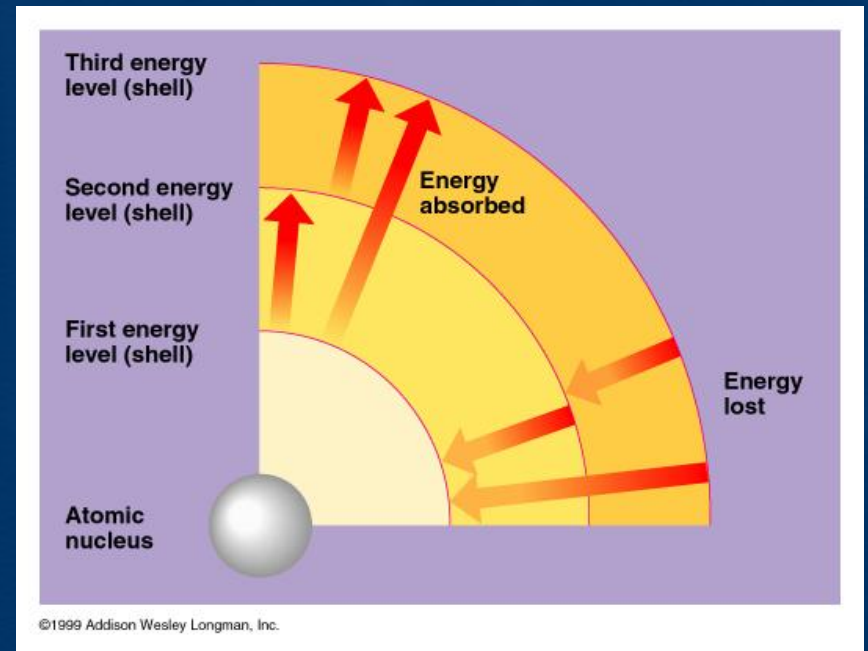
# SHELLS





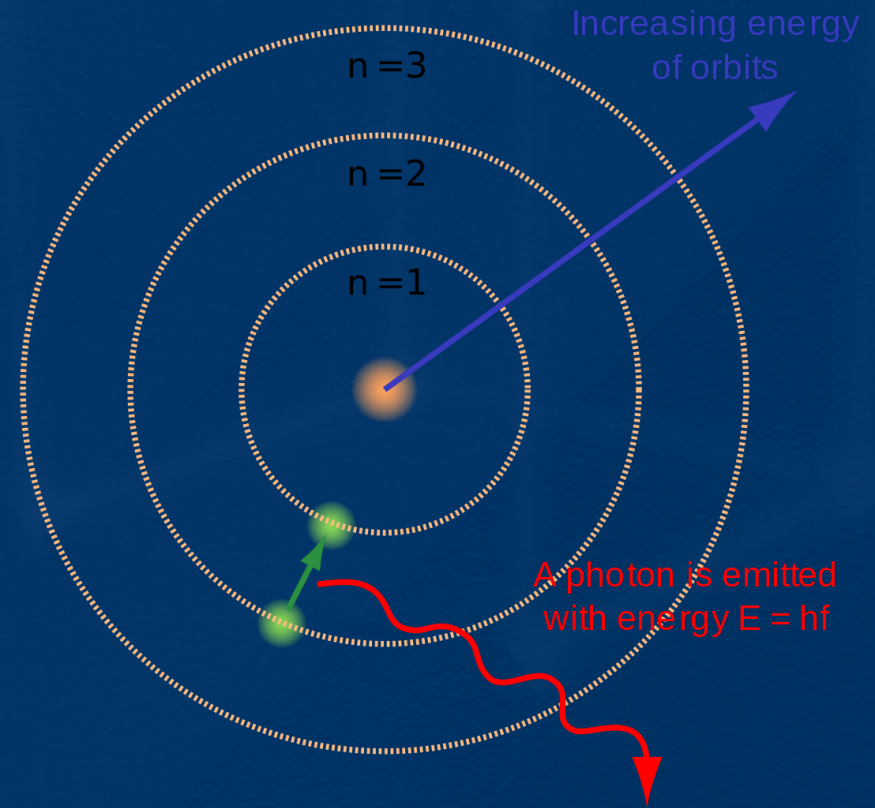
# Shells (aka Energy Levels)

- Shells are also known as energy levels.



# Shells III (aka Energy Levels)

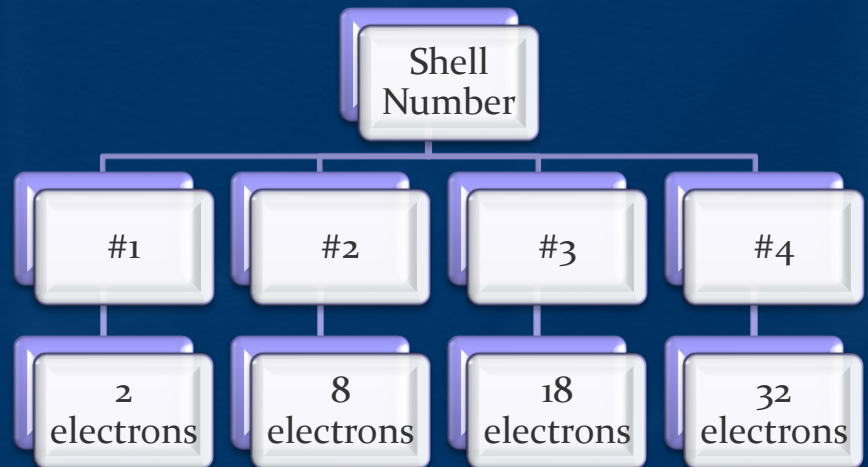
- In chemistry, shells are represented by numbers
  - 1 is for the 1<sup>st</sup> shell
    - Shell #1
  - 2 is used to represent the 2<sup>nd</sup> shell
    - Shell #2
  - 3 is used to represent the 3<sup>rd</sup> shell
    - Shell #3
  - 4 is used to represent the 4<sup>th</sup> shell
    - Shell #4





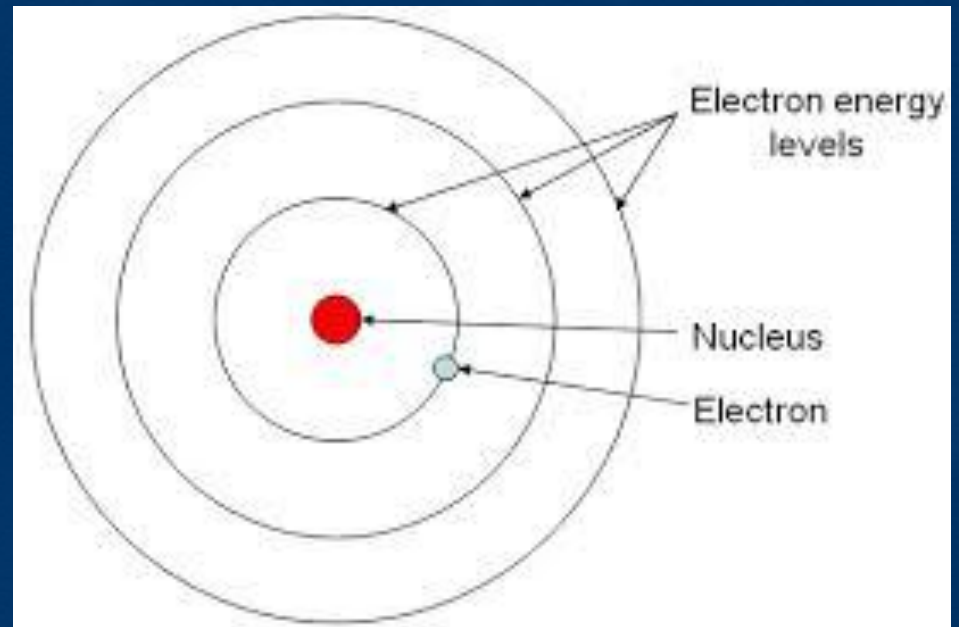
# Shells IV (aka Energy Levels)

- Each shell holds a maximum number of electrons
  - 1<sup>st</sup> shell  $\rightarrow$  2 e<sup>-</sup>
  - 2<sup>nd</sup> shell  $\rightarrow$  8 e<sup>-</sup>
  - 3<sup>rd</sup> shell  $\rightarrow$  18 e<sup>-</sup>
    - However, for row #3 only, Sodium (Na) to Argon (Ar), shell #3 holds a maximum of 8 e<sup>-</sup>
  - 4<sup>th</sup> shell  $\rightarrow$  32 e<sup>-</sup>



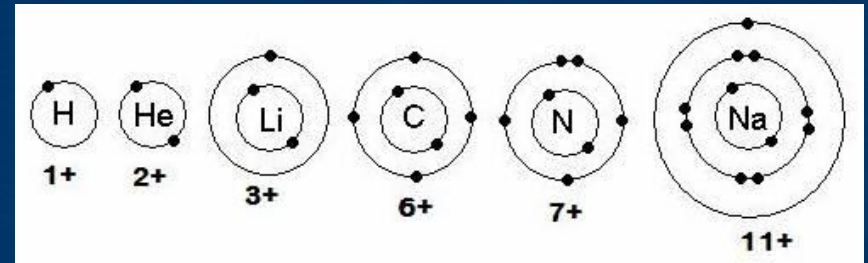
# Shells V

- The Bohr model is used to provide a visual representation of electrons spinning in shells.



# Valence Electrons

- Valence electrons are electrons found in the most outer shell.
- Valence electrons are used in the production of chemical bonds.



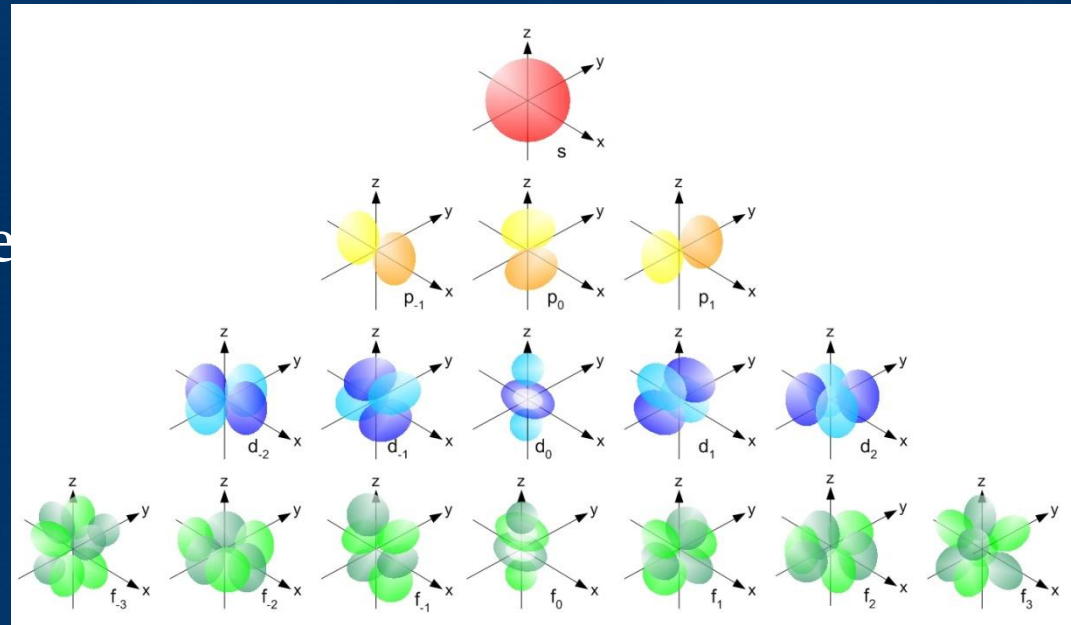


# ORBITALS



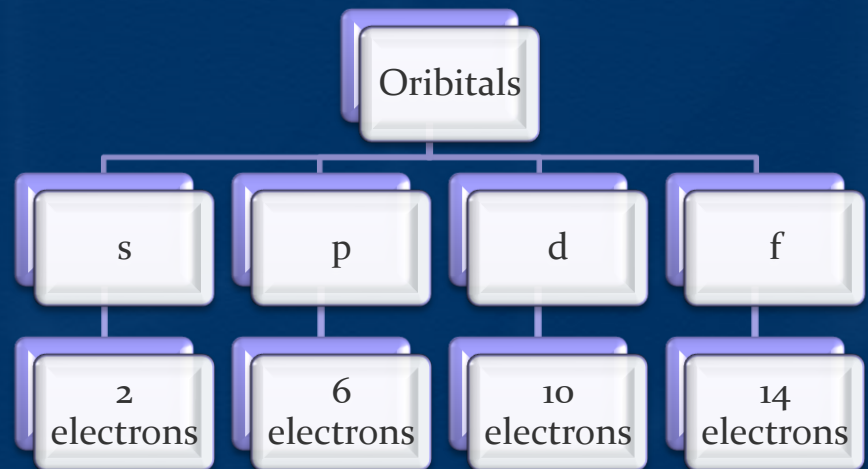
# Orbitals

- The volume of space, around the nucleus, where electrons are found.
- \*\*Used to calculate the number of electrons found in shells
- Represented by letters



# Orbitals

- Each orbital also has a maximum number of electrons
  - $s = 2$
  - $p = 6$
  - $d = 10$
  - $f = 14$
- The electron configuration displays the orbitals, and number of electrons found within, surrounding an atom.





# Electron Configuration

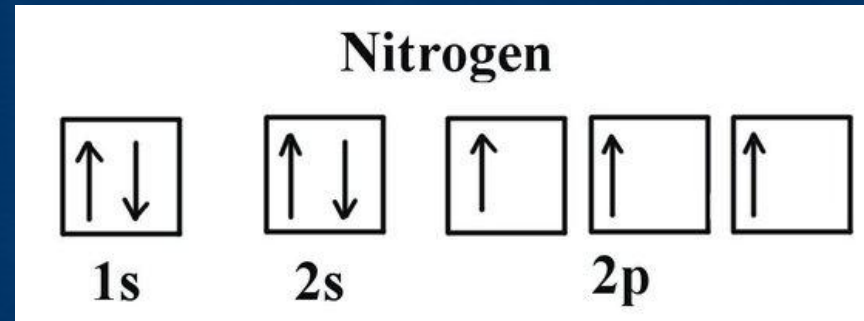
- The electron configuration is used as a visual representation of electrons spinning in orbitals.

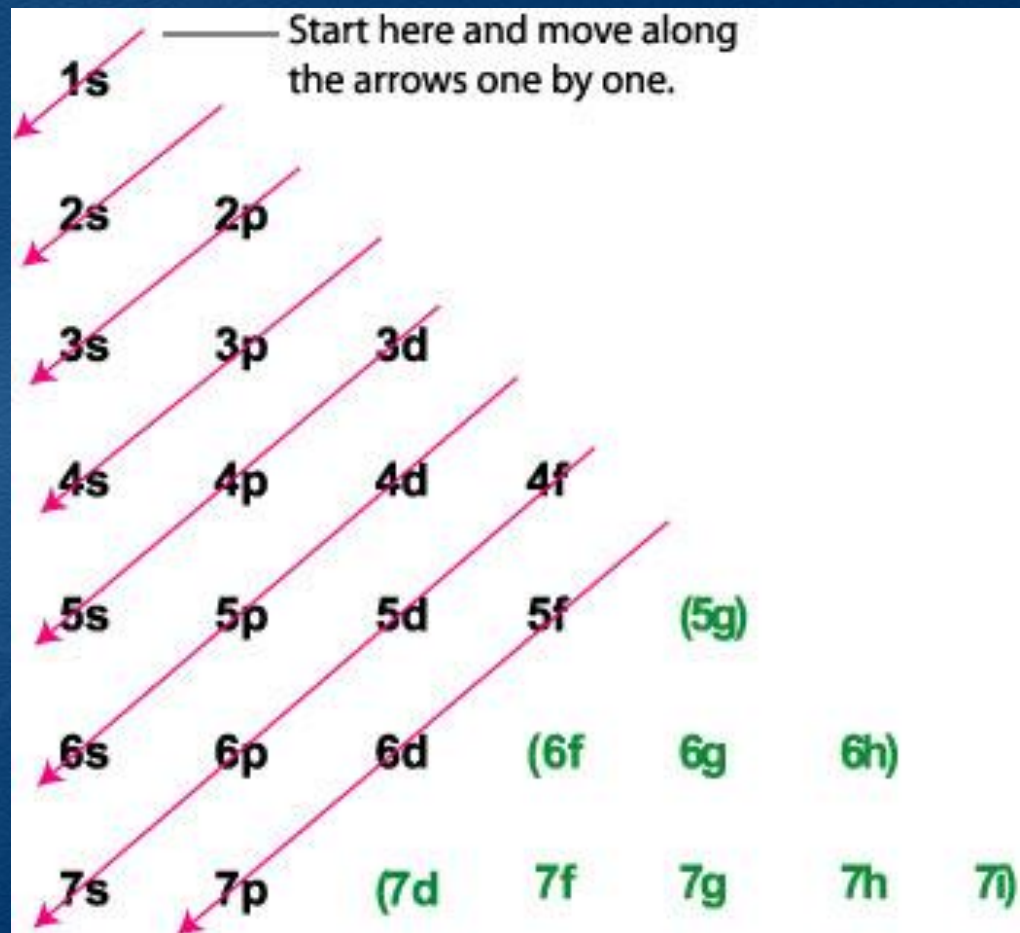
Example	electron notation	orbital notation		
hydrogen	$1s^1$	$\uparrow$	—	—
helium	$1s^2$	$\uparrow\downarrow$	—	—
lithium	$1s^2 2s^1$	$\uparrow\downarrow$	$\uparrow$	— — —
beryllium	$1s^2 2s^2$	$\uparrow\downarrow$	$\uparrow\downarrow$	— — —
boron	$1s^2 2s^2 2p^1$	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow$ — —



# Three Rules to Keep in Mind

- Aufbau Principle
  - Electrons occupy the orbitals of the lowest energy levels first
- Pauli Exclusion Principle
  - Two electrons occupying an orbital must have opposite spins
- Hund's Rule
  - Electrons occupy orbitals of the same energy in a way that makes the number of electrons with the same spin direction as large as possible
    - Spinning up for example





## Completing the Electron Configuration

Follow the arrows!



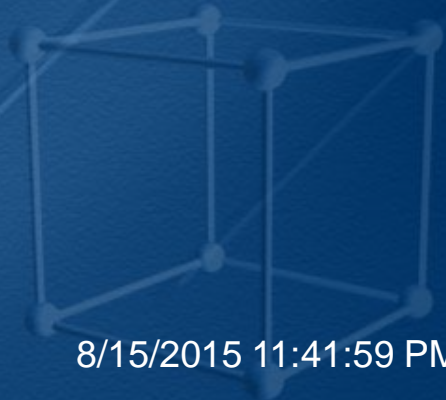


# HYBRIDS

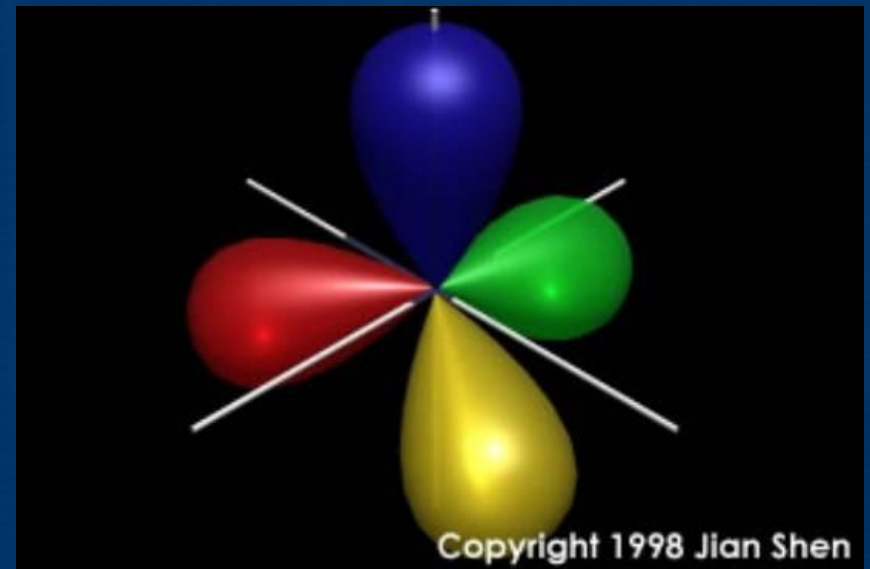
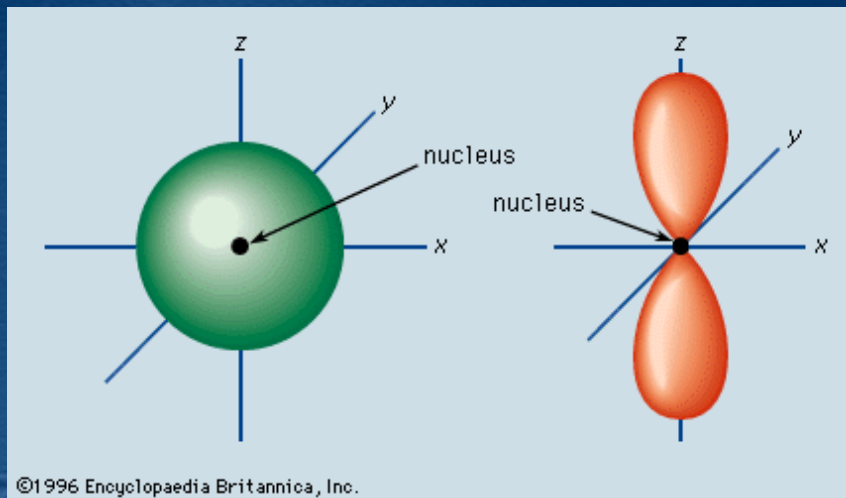


# Hybrids

- Developed by Linus Pauling in 1931
  - Showed mathematically how orbitals on an atom, can combine and hybridize, to form equivalent atomic orbitals.
- The concept explains how carbon forms four equivalent tetrahedral bonds but does not explain why it does so.



# From Orbitals to Hybrids





**REVIEW**

