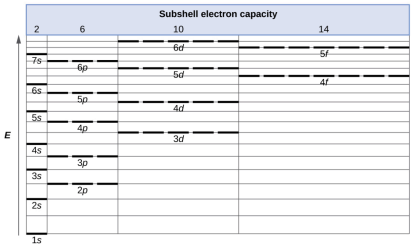
Introduction to Physical Science

Electron Configurations

Presented by Robert Wagner

Orbital Energies

- In general, energy of orbital increase as the principal quantum number increases
- Secondary quantum numbers:
  - s < p < d < f
- Pattern does not hold for larger atoms:
  - 3d is higher energy than 4s
  - 4s will fill first



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Electron Configuration

- The electron configuration of an atom is described with a symbol that contains three pieces of information
  - The number of the principal quantum shell, n
  - The letter that designates the orbital type, l
  - A superscript that designates the number of electrons that particular subshell

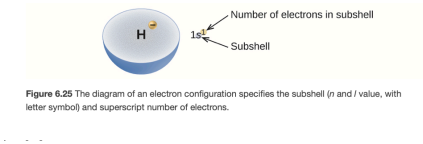

Figure 6.25 The diagram of an electron configuration specifies the subshell (*n* and *l* value, with letter symbol) and superscript number of electrons.

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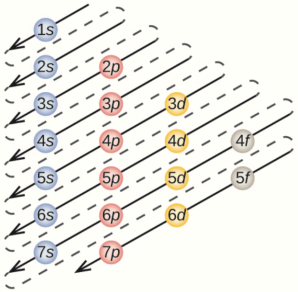
Aufbau Principle

- A way to "build up" the electron configuration of more complex elements
  - Each additional electron will occupy the lowest energy subshell available
- Diagram to help with ordering to fill shells



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Aufbau Principle

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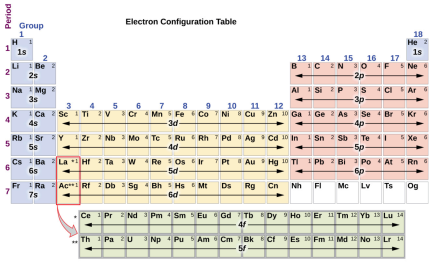

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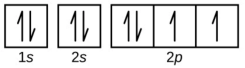
Examples

- Hydrogen
  -
- Helium
  -
- Oxygen
  -

H $1s^1$

He $1s^2$

O $1s^2 2s^2 2p^4$



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Valence Electrons

- Valence electrons are the electrons in the outermost shell
- Core electrons - inner shell electrons - corresponds to a noble gas configuration
  - Use noble gas as an abbreviation to write the electron configuration

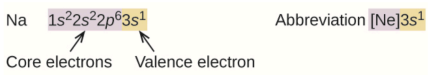

Figure 6.28 A core-abbreviated electron configuration (right) replaces the core electrons with the noble gas symbol whose configuration matches the core electron configuration of the other element.

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Example

- What is the electron configuration for a phosphorus atom? What atom has the configuration: ?

P : *Atomic number* $= 15$

1s = 2 electrons ; 2s = 2 electrons
2p = 6 electrons ; 3s = 2 electrons
3p = 3 electrons

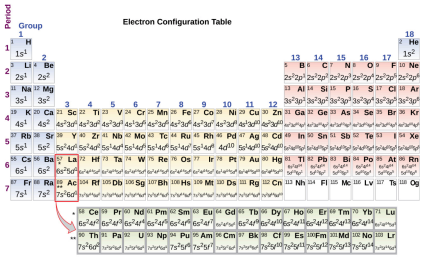
$1s^2 2s^2 2p^6 3s^2 3p^3$

$[Ar] 4s^2 3d^5$; Ar has 18 electrons so this atom has 25

Element 25 is manganese (Mn)

Electron Configurations and the Periodic Table

- Main group elements
  - Last electron added goes in an s or p shell
- Transition elements
  - Metallic elements where last electron goes in a d shell
- Inner transition elements
  - Metallic elements where the last added electron goes in an f shell



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Electron Configurations of Ions

- Recall:
  - Ions are formed when an atoms gains or loses electrons
- Lost electrons
  - Main group elements - last added are first removed
  - Transition elements - highest s shell electrons removed first, then d or f shell
- Added electrons
  - Follow the Aufbau principle

Example

- Write the electron configuration of
  -
  -
  -

Electrons Na: 11; P: 15 ; Fe: 26

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

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

$P: 1s^2 2s^2 2p^6 3s^2 3p^3$

$P^{3-}: 1s^2 2s^2 2p^6 3s^2 3p^6$

$Fe: 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$

$Fe^{2+}: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$

Summary

- Electrons will fill the lowest energy subshells first
- The Aufbau Principle is used to build up electron configurations
- Main group elements have different patterns for losing electrons than the transition metals