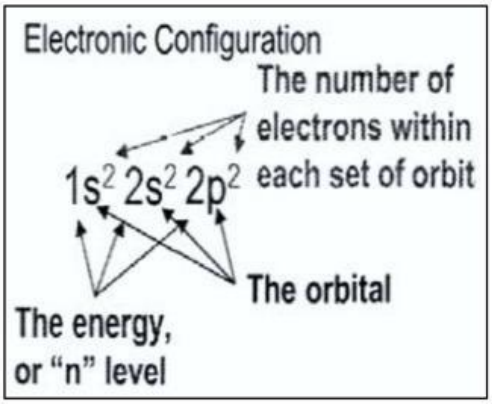
Student's Worksheet

Electron Configuration

Brief Instructions

An electron configuration is a method of indicating the arrangement of electrons about a nucleus. A typical electron configuration consists of numbers, letters, and superscripts with the following format:

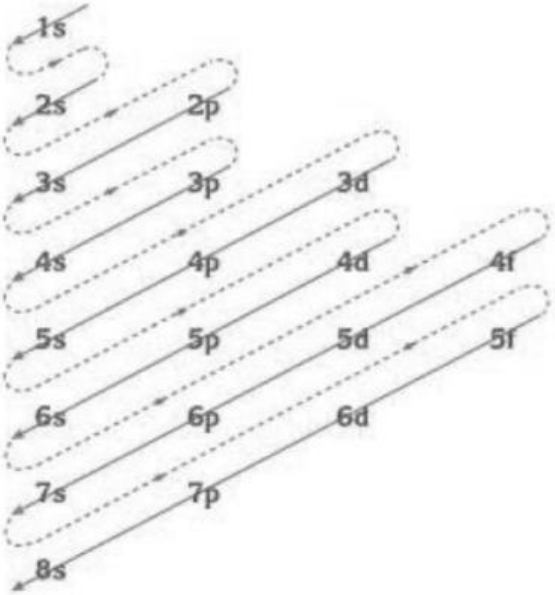
1. A number indicates the energy level (The number is called the principal quantum number.).
2. A letter indicates the type of orbital; s, p, d, f.
3. A superscript indicates the number of electrons in the orbital. Example: ls^2 means that there are two electrons in the 's' orbital of the first energy level. The element is helium.



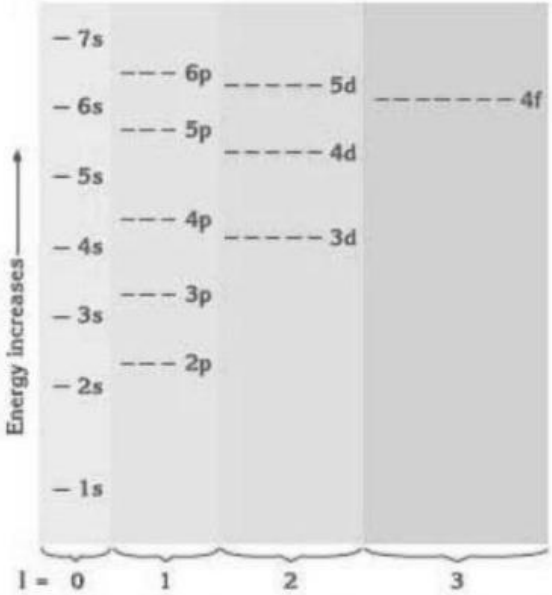
How to write an electron configuration

A. Determine the total number of electrons to be represented.

B. Use the Aufbau process to fill the orbitals with electrons. The Aufbau process requires that electrons fill the lowest energy orbitals first. In another words, atoms are built from the ground upwards.



The Aufbau order of filling the atomic orbitals.



General order of filling of the orbitals in an atom.

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

C. The sum of the superscripts should equal the total number of electrons.

Example: $_{12}Mg : ls^2\ 2s^2\ 2p^6\ 3s^2$

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Configuration Writing Practice

Write a **ground state** electron configuration for each neutral atom. **Ground state** means that all of the lowest possible energy levels (up to the proper number of electrons for the element) are filled.

Element	Complete Configuration	Element	Complete Configuration
$_{1}H$		$_{21}Sc$	
$_{3}Li$		$_{25}Mn$	
$_{5}B$		$_{47}Ag$	
$_{8}O$		$_{30}Zn$	
$_{9}F$		$_{28}Ni$	
$_{11}Na$		$_{26}Fe$	
$_{13}Al$		$_{22}Ti$	
$_{14}Si$		$_{29}Cu$	
$_{15}P$		$_{46}Pd$	
$_{17}Cl$		$_{23}V$	

Electronic Configuration Shorthand

Consider the electronic for Argon and Calcium:

Ar: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ ← As a noble gas, Argon's orbitals are completely filled.

Ca: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

[Ar] $4s^2$ ← We can use the "last" noble gas as a shorthand in electronic configurations!

The "core" electrons

The "valence" electrons

For the following electron configurations choose elements they may represent.

1) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2\ 3d^{10}\ 4p^4$
2) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2\ 4f^{14}\ 5d^{10}\ 6p^6\ 7s^1$
3) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2\ 4f^{14}\ 5d^{10}\ 6p^4$
4) [Kr] $5s^2\ 4d^{10}\ 5p^3$
5) [Xe] $6s^2\ 4f^{10}$

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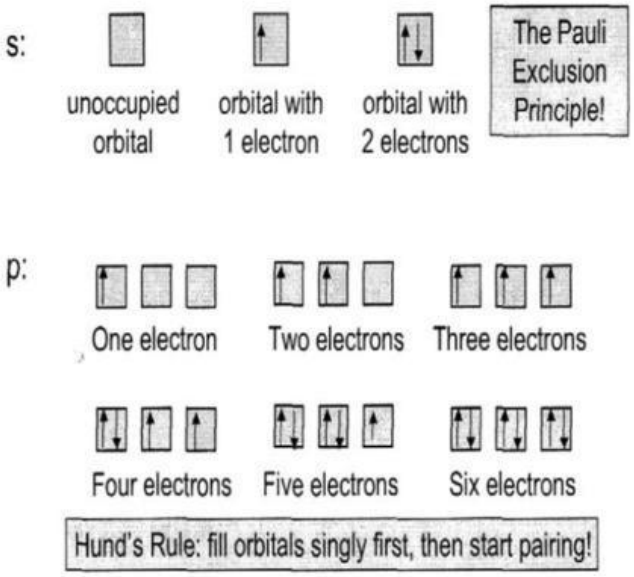
Orbital Filling Diagrams

Electron may be described by a set of the four **quantum numbers, n, l, m_l, m_s**;

- **n** shows the shell and the relative average distance of the electron from the nucleus
- **l** shows the subshell and the shape of the orbital for the electron
- **m_l** represents the orientation of the orbital in spaces
- **m_s** refers to the spin of the electron.

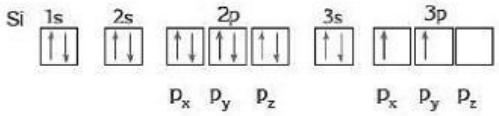
Rules of electron distribution;

1. Pauli's Principle
   "In the same atom, two electrons may not have identical sets of all quantum numbers"
2. The Aufbau Principle
   "The lowest energy orbitals are filled first"
3. Hund's Rule
   "The electrons are distributed among the orbitals of subshell of the same energy in a way that gives the maximum number of unpaired electrons with parallel spin"



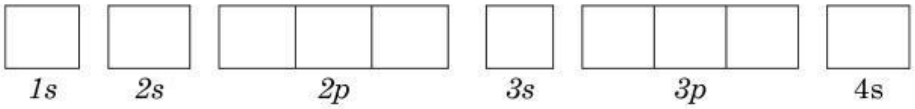
Example: $_{14}Si$: $1s^2\,2s^2 2p^6\,3s^2 3p^2$

Orbital diagram notation :

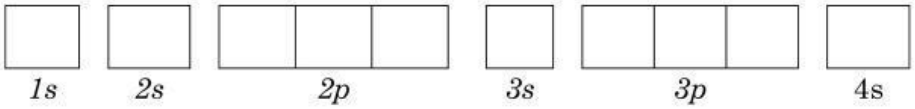


Orbital Filling Diagrams Practice

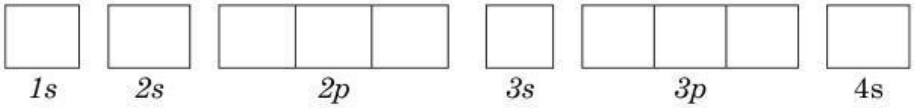
1. Nitrogen



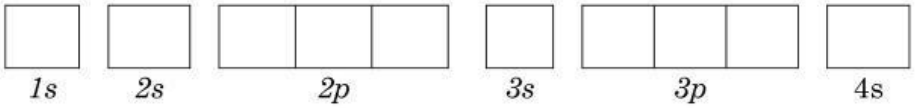
2. Chlorine



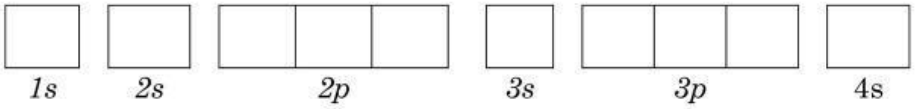
3. Sodium



4. Neon



5. Potassium



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Configuration Writing for Ions

Remember that **ions** have a **change in the total number of electrons** (positive have lost electrons and negative have gained).

Example: $_7N^{3-}$: $1s^2\ 2s^2\ 2p^6$. It has three extra electrons.

Write a ground state electron configuration for these ions.

1. $_8O^{2-}$:
2. $_{26}Fe^{2+}$:
3. $_5B^{3+}$:
4. $_{28}Ni^{2+}$:
5. $_{19}K^{+}$:
6. $_{17}Cl^{-}$:

Multiple Choice Questions

13. Which one of te following electron structures belongs to the ion $_{12}Mg^{2+}$?

A) [Ne]$3s^1$ B) [Ne]$3s^2$ C) [Ne]
D) $1s^2\ 2s^2\ 2p^4$ E) $1s^2\ 2s^2\ 2p^5$

14. Which one of the following electron distributions does not follow Hund's rule?

A) $1s^2\ 2s^2\ 2p^2_x\ 2p^1_y\ 2p^1_z$ B) $1s^2\ 2s^2\ 2p^1_x\ 2p^1_y$
C) $1s^2\ 2s^2\ 2p^1_x\ 2p^1_y\ 2p^1_z$ D) $1s^2\ 2s^2\ 2p^2_x\ 2p^1_y\ 2p^0_z$
E) $1s^2\ 2s^2\ 2p^2_x\ 2p^2_y\ 2p^1_z$

15. What is the atomic number of an element having a total of 5 electrons in n = 4?

A) 24 B) 28 C) 30 D) 33 E) 35

16. In a compound X_2O_3, the ratio of the mass of X to the mass of compound is 7/19. If the atom of element X has a total of 7 neutrons in its nucleus, what is the electron configuration of X?

A) $_9X$: $1s^2\ 2s^2\ 2p^5$ B) $_8X$: $1s^2\ 2s^2\ 2p^4$
C) $_7X$: $1s^2\ 2s^2\ 2p^3$ D) $_6X$: $1s^2\ 2s^2\ 2p^2$
E) $_5X$: $1s^2\ 2s^2\ 2p^1$

17. Which one of the following electron distributions does not follow the Aufbau principle?

A) $_9F$: $1s^2\ 2s^2\ 2p^5$ B) $_8O$: $1s^2\ 2s^2\ 2p^4$
C) $_7N$: $1s^2\ 2s^2\ 2p^3$ D) $_6C$: $1s^2\ 2s^1\ 3s^2\ 3p^1$
E) $_5B$: $1s^2\ 2s^2\ 2p^1$

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