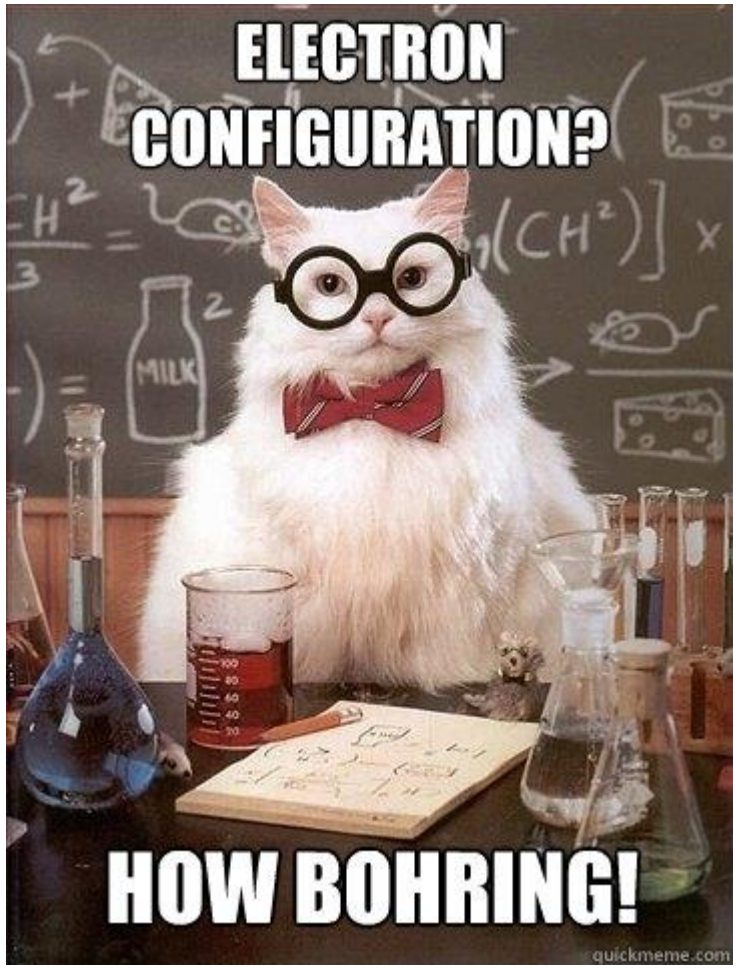
Electron Configurations



Outcomes:

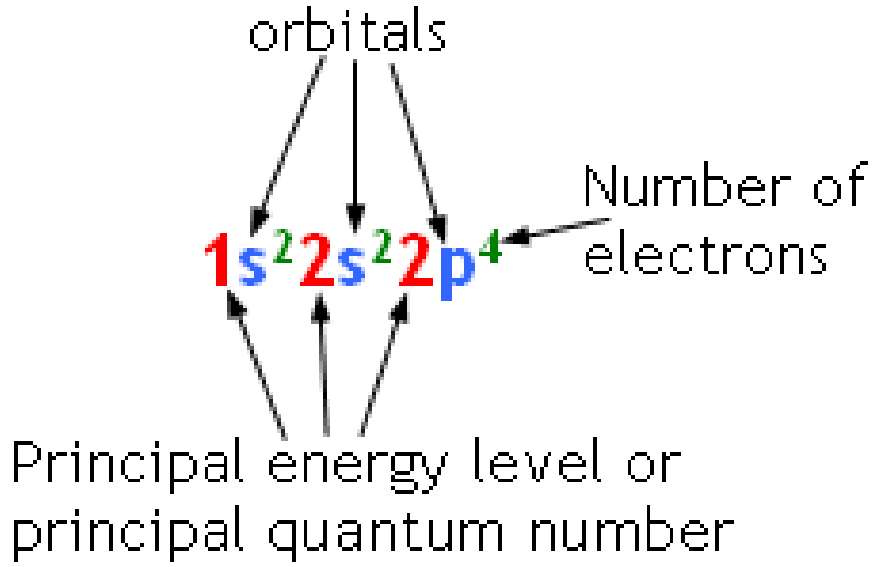
Write electron configurations for elements of the periodic table. *Include: selected elements up to atomic number 36 (Krypton)*

Relate the electron configuration of an element to its valence electron(s) and its position on the periodic table.

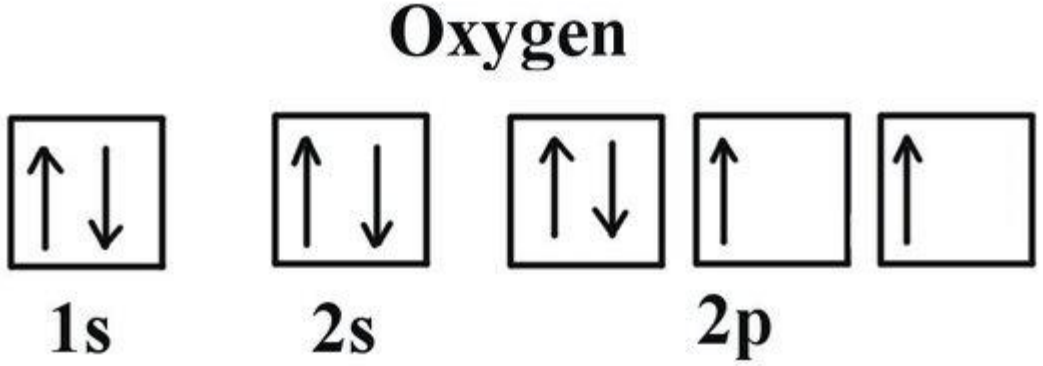
Electron Configurations

Writing the Electron Configuration

- We use a **STANDARD NOTATION** for writing electron configurations.
- The number includes the **PRINCIPAL ENERGY LEVEL (n)** of the electron, the **NAME** of the **ORBITAL** and the **NUMBER** of **ELECTRONS** in that orbital.
- The electron configuration of oxygen is:



Electron Configurations



The electron configuration shows that there are:

- ***2 electrons in the s-orbital of the first energy level ($1s^2$)***
- ***2 electrons in the s-orbital of the second energy level ($2s^2$)***
- ***4 electrons in the p-orbital of the second energy level ($2p^4$)***

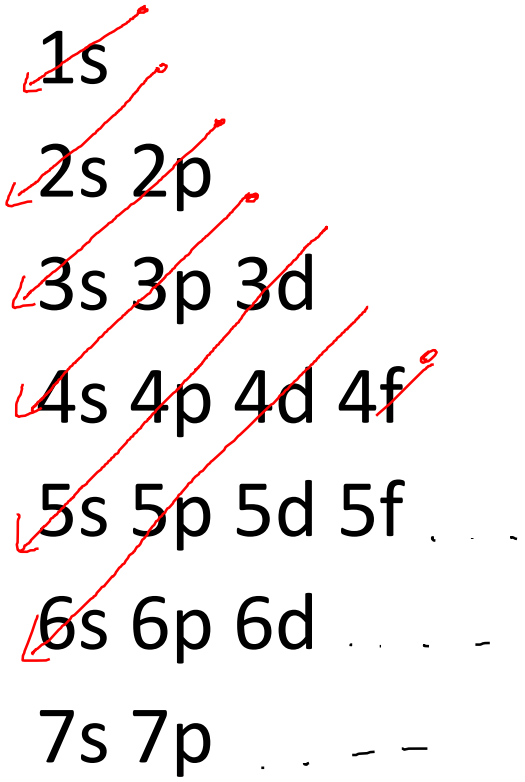
NOTE:

The **ORBITALS** are always written as **LOWER CASE** letters and the **NUMBER** of **ELECTRONS** is always written as **SUPERSCRIPTS**.

Electron Configurations

The Zig-Zag Rule:

- The **OVERLAP** between d, f, and s-orbitals makes remembering electron configurations difficult.
- Start by writing the orbitals out in a **LIST** downwards:



Electron Configurations

The Zig-Zag Rule:

- We can draw a **DIAGONAL LINE** through the orbitals.

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

- To write the filling order we just follow the diagonal lines.
- When we reach the tip (end) of an arrow, we start at the tail (start) of the next arrow.
- The filling order is:

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

Electron Configurations

Examples:

Write the electron configuration for the following:

Calcium

20e⁻

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

Germanium

32e⁻

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^2$

Neon

10e⁻

$1s^2\ 2s^2\ 2p^6$

Electron Configurations

Neon: $1s^2 2s^2 2p^6$
#10

Try these ones…

Write the electron configuration for the following:

Sodium
#11

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

Magnesium
#12

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

Aluminum
#13

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

Noble Gas Notation

If you look at the "try these ones" above, what do you notice?

→ They all start with ***1s²2s²2p⁶*** ← Neon!

We can **SHORTEN** the electron configuration of an element by using the symbol for the **NOBLE GAS** before it.

Our try these ones would now look like this:

Sodium

[Ne] $3s^1$

Magnesium

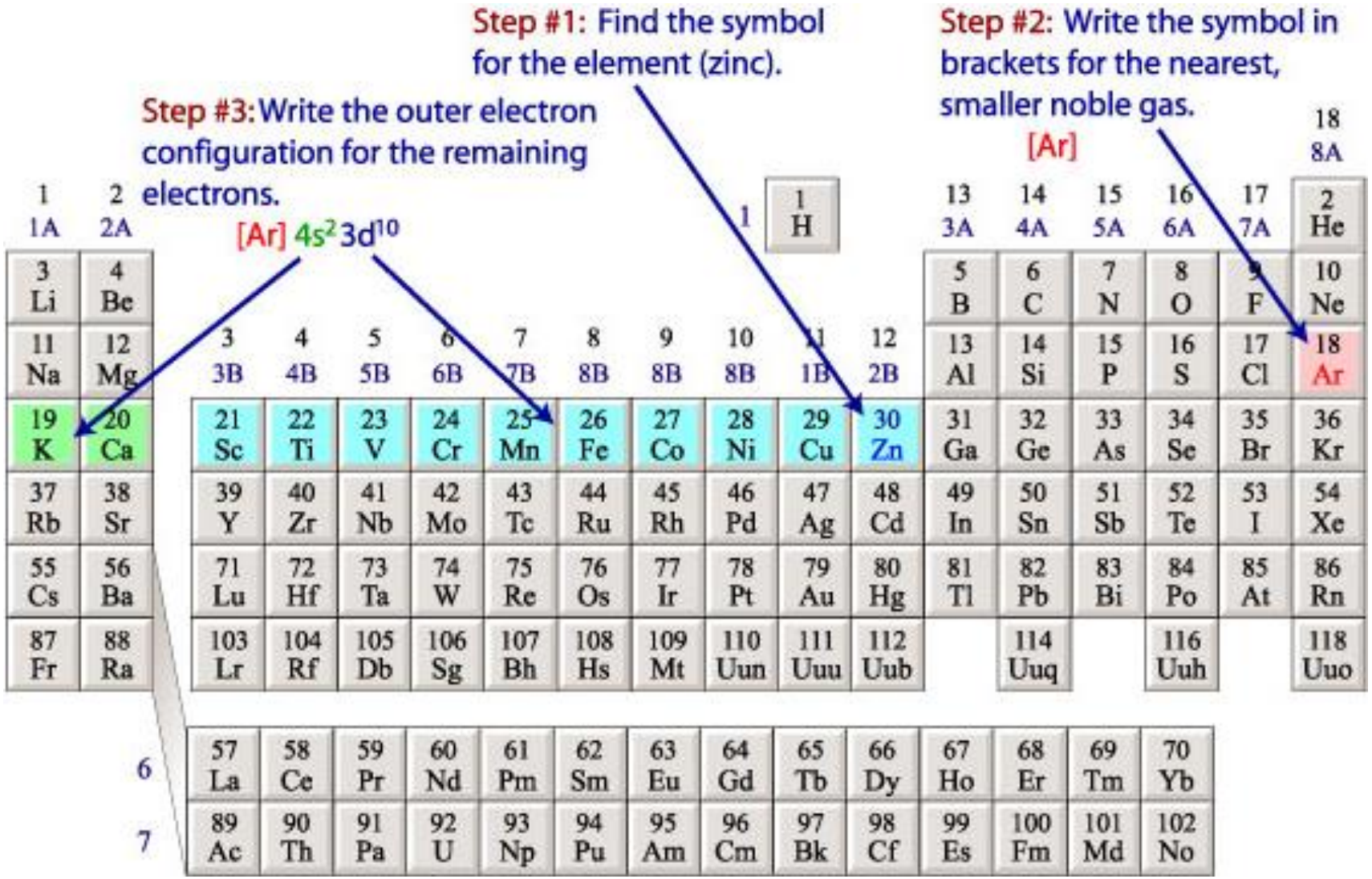
[Ne] $3s^2$

Aluminum

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

In fact, this is how many periodic tables display the electron configurations…

Noble Gas Notation



http://www.mpcfaculty.net/mark_bishop/abbreviated_electron_configuration_help.htm

Electron Configuration of Ions

- When writing the valence configurations of **IONS** you must consider the **CHARGE** of the ion.
  - The charge will determine the **NUMBER** of **ELECTRONS**.
- A **POSITIVE** ion will have **FEWER** electrons and a **NEGATIVE** ion will have **MORE** electrons.

Examples:

Write the electron configurations for the following:

Calcium Ion (Ca^{2+})

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0$

Chloride Ion (Cl^-)

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

Copper(II) Ion (Cu^{2+})

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^9$

Valence Electron Configurations

Valence electrons are found in the outermost energy level, or have the highest principle quantum number (n).

Examples:

Write the valence electron configuration for the following:

Fluorine

Solution…

Step 1. Write the complete electron configuration.

Fluorine = 9 electrons

$$1s^2 2s^2 2p^5$$

Step 2. Choose the electrons in the highest energy level.

The highest energy level is the second, so the electrons in the second energy level are the valence electrons.

The valence configuration is $\underline{2s^2 2p^5}$

Valence Electron Configurations

Examples: (Con't)

Germanium

Solution…

Step 1. Write the complete electron configuration.

Germanium = 32 electrons

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

Step 2. Choose the electrons in the highest energy level.

The highest energy level is the fourth, so the electrons in the fourth energy level are the valence electrons.

The valence configuration is $\underline{4s^2 4p^2}$

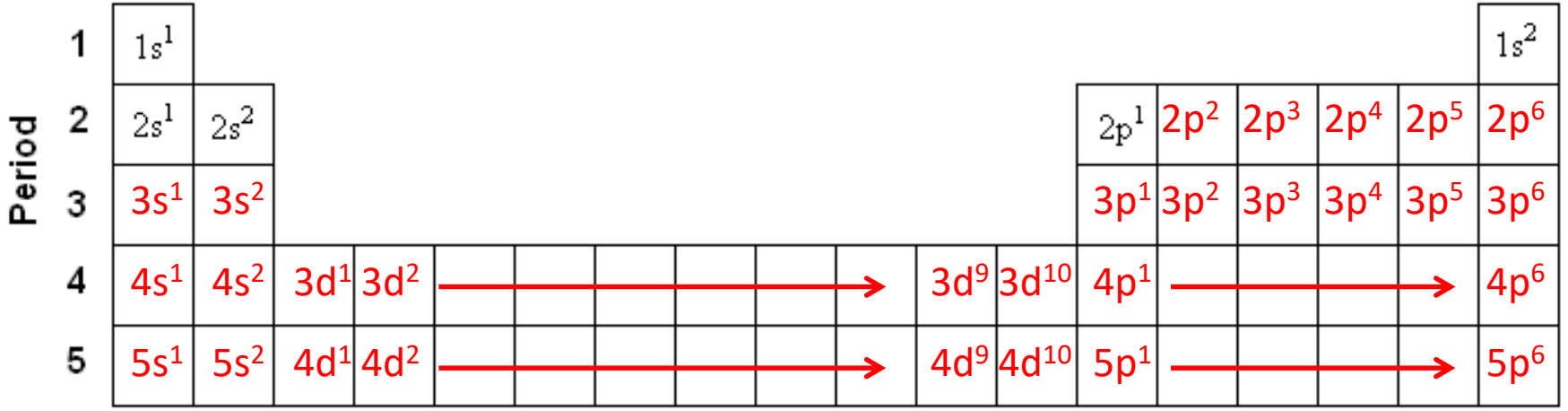
NOTE:

Even though the 3d orbital fills after the 4s orbital, the 4s orbital is in the highest or outer-most energy level.

Electron Configurations

Electron Configurations and the Periodic Table

In the periodic table below, write the last orbital of each elements configuration in each box.
It has been started for you…

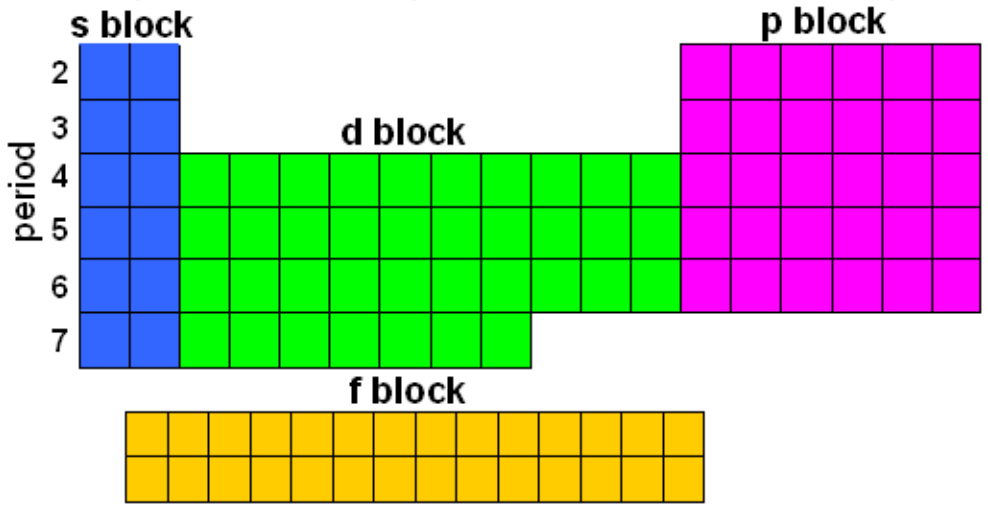


Do you notice any trends in the table?

Electron Configurations

Periodic Trends

The periodic table seems to be arranged according to the electron configuration of the atoms:



- The electron configuration of atoms in these 4 areas will have the indicated orbital filling **LAST**. (Ex. transition metals fill the d-orbitals)
- Another trend is the **ENERGY LEVEL** of the valence electrons is the **SAME** as the **PERIOD** of the atom. Note that the 1st period is omitted above.
- We have learned before that elements in **COLUMNS** or **GROUPS** have **SIMILAR PROPERTIES** because they have **SIMILAR VALENCE** electron configurations.
- An element's chemical **PROPERTIES** and **BONDING** characteristics are determined by its **VALENCE ELECTRONS**.

Electron Configurations

Periodic trends:

Here are a couple of different periodic tables that may help you to determine electron configurations...

Periodic Table with Electron Configs.pdf

s, p, d, f Blocks Table