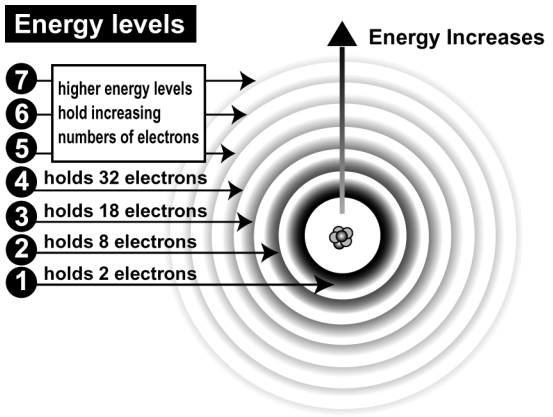
Name: _____

Skill Sheet 18-B Electrons and the Periodic Table

What do electrons have to do with the periodic table? In this skill sheet, you will learn how electrons are organized in the energy levels that orbit the nucleus of an atom. You will also discover the relationship between electrons and the organization of the periodic table.

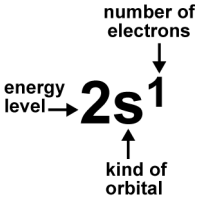
1. How do you describe the location of an electron?

As you have learned, electrons "live" in one of the seven **energy levels** surrounding the nucleus of the atom. Generally speaking, the farther away from the nucleus the energy level, the greater the amount of energy required for an electron to occupy that level. Electrons tend to fill in the first energy level first, the second energy level second, and so on, because they fill the levels from lowest to highest energy, that is, from first to outermost.



Energy levels are divided into smaller regions called **orbitals**. Each orbital designates a specific region of the energy level where an electron exists. The different orbitals are designated by the letters **s**, **p**, **d**, and **f**.

Electrons fill the energy levels and orbitals in a certain order. The position that has the lowest energy is filled first. The position that has the lowest energy is in the first energy level (the level closest to the nucleus), in the **s** orbital. This electron's position is represented by writing: $\mathbf{1s^1}$.



The order in which electrons fill *all* seven energy levels (1-7) and *all* electron orbitals (**s**, **p**, **d**, and **f**) is shown below. This order (going from left to right) is called an **electron configuration**.

Electron configuration for ununoctium

Lowest energy	→	→	→	→	→	Highest energy

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

Each element on the periodic table has a unique electron configuration, based on its atomic number This number tells you the number of electrons in a neutral atom of the element. For example, hydrogen's electron configuration is $1s^1$ and carbon's electron configuration is $1s^2 2s^2 2p^2$. The electron configuration above (which includes all the energy levels and orbitals on the periodic table) is for ununoctium (Uuo), the very last element on the periodic table.

In the fourth, fifth, sixth, and seventh energy levels, you will notice orbitals with numbers from a lower energy level. For example, the 4s and 4p orbitals and the 3d orbital are all in the fourth energy level. This is because the energy level of the 3d electrons overlaps with the energy levels for electrons in the fourth energy level. Also, the 4s orbital is filled before the 3d orbital. This is because the 4s orbital has a lower energy than the 3d orbital. To complicate matters, electrons fill the **d** and **f** orbitals in irregular patterns.

2. Writing electron configurations

Can you write the electron configuration for gallium? Since this may be your first time, we'll do this one together by following the steps below.

1. Locate the element on the periodic table.

   Look at a periodic table and locate gallium. Its symbol is Ga. Use the atomic number to determine how many electrons a neutral atom of gallium has.

   Gallium has 31 electrons.

2. Fill orbitals in the proper sequence with electrons.

   Use table on the previous page as a guide for the order of filling each energy level and orbital. Keep filling orbitals until you have placed all the electrons of the element. The electron configuration for gallium is:

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

3. Check to make sure that the total number of electrons in the configuration (the superscripts) is equal to the atomic number.

   2 + 2 + 6 + 2 + 6 + 2 + 10 + 1 = 31

   Congratulations! You have successfully written an electron configuration. You'll have plenty more practice as you work through this skill sheet.

3. An easier way to write electron configurations

You can save yourself a lot of time (and space in your notebook) if you use an abbreviated form of writing electron configurations using noble gases. Here's an example of how to do this with the electron configuration for gallium:

Gallium is in the fourth period. You can substitute the electrons that are in the third period of the periodic table with the symbol for the noble gas that is in that period. What is the noble gas in the third period? Remember that elements in the last column of the periodic table (group 18) are the noble gases.

Argon is the noble gas in the third period. To write the abbreviated electron configuration for gallium, substitute the symbol for argon, in brackets, for the electron configuration of the first three periods. Next, write the rest of gallium's electron configuration.

Electron configuration for gallium:

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

$$[1s^2 2s^2 2p^6 3s^2 3p^6] = argon + 4s^2 3d^{10} 4p^1$$

The abbreviated electron configuration for gallium is:

$$[Ar] 4s^2 3d^{10} 4p^1$$

Writing abbreviated electron configurations is a convenient way to see how many electrons are in the outermost s and p orbitals of an atom. These are the electrons that are involved in forming chemical bonds. How many electrons does gallium have in its outermost s and p orbitals? *Answer: 3 electrons*

4. Writing electron configurations for some of the elements

Write abbreviated electron configurations for the following elements. Use a periodic table to locate the elements and determine the number of electrons. Finally, fill in the last column of the table. For elements in the lanthanide or actinide series, write "lanthanide" or "actinide" instead of a group number.

Element	Electron configuration (abbreviated form)	To which group does this element belong?
K		
Rb		
Mg		
Ba		
Tl		
Ga		
Pb		
Sn		
Mo		
N		
Sb		
Pt		
Se		
Po		
Br		
Gd		
Cl		
Kr		
U		
Rn		

5. Identifying patterns in the arrangement of elements on the periodic table

Look at the table you have just filled in. Do you see any patterns in the electron configurations and group numbers? Use the patterns you see in the electron configurations to answer the following questions.

1. In the main group elements (the tall columns on the periodic table), what is the relationship between group number and number of electrons in the outermost **s** and **p** orbitals?

2. Which elements in the table you completed belong to the transition metals? What do their electron configurations have in common?

3. Which elements in the table you completed belong to the lanthanide and actinide series (the two separate rows at the bottom)? What do their electron configurations have in common?

4. Which elements have a completely full outermost energy level? Where are they located?

6. Valence electrons

In the main group elements, the electrons in the **s** and **p** orbitals of the outermost energy level are called **valence electrons**. These electrons are involved in forming chemical bonds.

1. How many electrons can the **s** orbital of a given energy level hold?

2. How many electrons can the **p** orbital of a given energy level hold?

3. If valence electrons include the electrons in the **s** and **p** orbitals for an energy level, what is the maximum number of valence electrons an atom can have?

4. How is the placement of an element on the periodic table related to the number of valence electrons the element has?