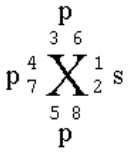
Chemical Bonding

Lewis Diagrams

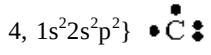
The forces that hold atoms together in a compound result in what is called a **chemical bond.** Bonding takes place because of an interaction between outermost electrons of different elements. The outermost electrons of an atom that are directly involved in bonding are called the **valence electrons. Lewis diagrams** are used to demonstrate chemical bonding as these diagrams only depict valence electrons. The rules for Lewis diagrams are as follows (incorporating quantum theory):

1. the inner electrons and atomic nuclei are represented by symbol of element
2. valence electrons are depicted as dots or stars etc. drawn around symbol of element
3. for atoms in their ground or non-bonding state theses electrons are arranged in order as follows:

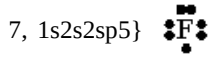


Consider some examples:

Na {group 1, $1s^2 2s^2 p^6 3s^1$} 

C {group 4, $1s^2 2s^2 p^2$} 

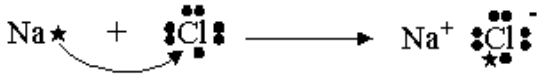
Be {group 2, $1s^2 2s^2$} 

F {group 7, 1s2s2sp5} 

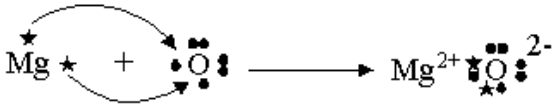
The atoms of elements in same chemical family all have same number of dots; thus, the number of valence electrons equals family number in periodic table.

Ionic Bonding

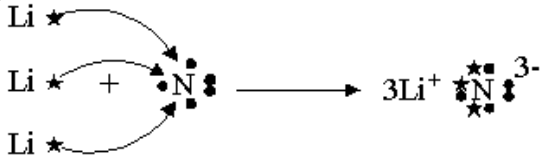
Elements react to become stable which allows them to obtain the electronic configuration of a noble gas; thus, elements react is such a way as to have 8 (or sometimes 2) outer electrons. Recall that metals react by losing electrons. Generally elements with 3 valence electrons or less react by losing electrons (easier). The metal atom becomes a positive ion and has the electronic configuration of a noble gas. Recall that non-metals react by gaining electrons (easier). Generally elements with 5, 6 or 7 valance electrons react by gaining electrons. The non-metal atom becomes a negative ion and also obtains the electronic configuration of a noble gas. Therefore, when a metal and a non-metal interact, they often react with each other such that the non-metal takes the valence electrons from the metal atom since the metal atom has a weaker hold on these outermost electrons and the non-metal has a stronger nuclear attraction to its outermost electrons. This electron transfer results in a positively charged metal ion and a negatively charged non-metal ion and both atoms have now obtained the electronic configuration of a noble gas. The attraction between these oppositely charged ions is called an **ionic bond**. For example consider the reaction between sodium and chlorine atoms:



The result is the formation of the ionic solid, NaCl. It might be difficult to release that the Na^+ ion is now stable, but look at the electronic configuration. Sodium was $1s^2 2s^2 p^6 3s^1$ and becomes $1s^2 2s^2 p^6$ which is the electron configuration of neon. Consider another example in which magnesium reacts with oxygen to form MgO.



Notice that you must show the transfer of electrons, so use different dots for different elements and you must show the final result with charges and electrons where appropriate using the same dots to depict different sources of electrons. Consider the bonding between lithium and nitrogen.



You can use as many atoms of any element as needed since there is always numerous atoms present in any sample. Also, always bond with the fewest number of atoms as possible and keep the structure as simple as possible. You can put brackets around the atoms such as $3[Li^+]$ to indicate the number ions within the bracket (this is especially helpful if there are multiple negative ions present). Note that there is no actual connection made between the metal and the non-metal; they are only held together by attraction of opposite charges and if these compounds are dissolved in water the charges can be separated.