Unraveling the Secrets of Chemical Reactions

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Abstract:

This article is meant to help students who have trouble in covalent and ionic bonding and it is designed to help them understand this concept better while providing examples and diagrams to make the concept easier to understand as a whole.

Introduction:

By reading this article, students will be able to understand covalent and ionic bonding much better than before and they will be able to solve problems relating to this concept with no problems. This article is purely for informative purposes on the topic of Chemical Reactions.

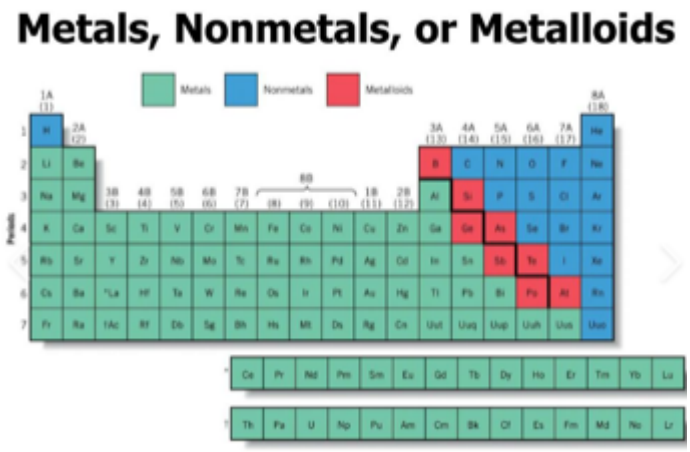
What is Bonding?

Bonding refers to the interactions that take place between atoms, molecules, and ions. It is also known to be the interactions between charged particles like electrons and protons.

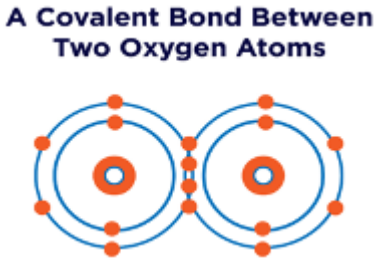
What is Covalent Bonding?

Covalent Bonding is the “sharing” of electrons between two atoms in overlapping orbitals. Nonmetals usually bond to other nonmetals to form a covalent bond. The two nonmetals “share” electrons with each other and due to their high ionization energies, they cannot form positively charged ions and can only gain electrons. Nonmetals are the only type of elements on the periodic table that can form covalent bonds.

The elements in blue are all the nonmetal elements on the periodic table that can form covalent bonds. (Notice how all of the nonmetals only lose electrons to form a stable octet as their Noble Gases)



This image shows two (nonmetal) oxygen atoms being covalently bonded together:



Notice in the diagram above how four electrons are being “shared” between the two Oxygens. This is how a covalent bond looks like when two nonmetals are bonded together.

How do we write a Covalent Bond?

1. Add -ide suffix at the end of second nonmetal element
2. Use a prefix that indicates how many of each atom are present

1- Mono
2- Di
3- Tri
4- Tetra
5- Penta

6- Hexa
7- Hepta
8- Octa
9- Nona
10- Deca

*Mono is never to be put in front of the first non metal in a covalent bond

Examples:

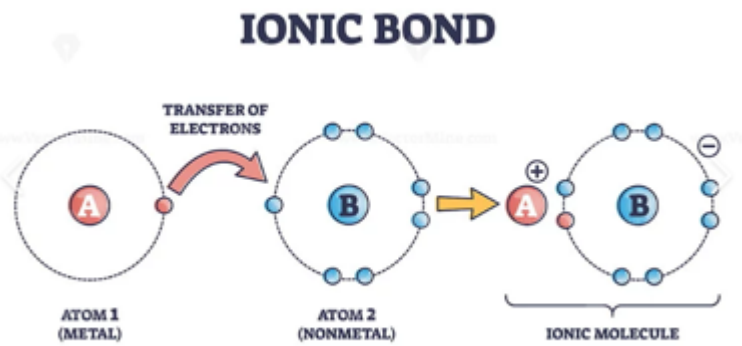
CO2 = carbon dioxide (there is only one carbon so you write carbon as it is as you cannot use mono for the first element. We see that there are two oxygens so we use the prefix di and write 'dioxide')

P2O5 = Diphosphorus Pentoxide (We see that there are two phosphorus elements in the compound so we add the prefix 'di' in front of the element to get diphosphorus and we see that there are 5 oxygens in the compound so we use the prefix for five which would be penta and put it in front of the oxygen ion by keeping in mind to turn the ending into -ide. The oxygen atom ends up becoming pentoxide. It would be correct to write pentaxoide or pentoxide.)
Silicon Dioxide = SiO2 (Silicon Dioxide is a covalent bond because of the prefixes in front of the oxygen ion. Since silicon has no prefix in front of it, we can assume that there is only one silicon ion and just write 'S' in its formula. We see that there is the prefix 'di' in front of the oxygen ion so we write O2 to show that there are two oxygens in the compound.)

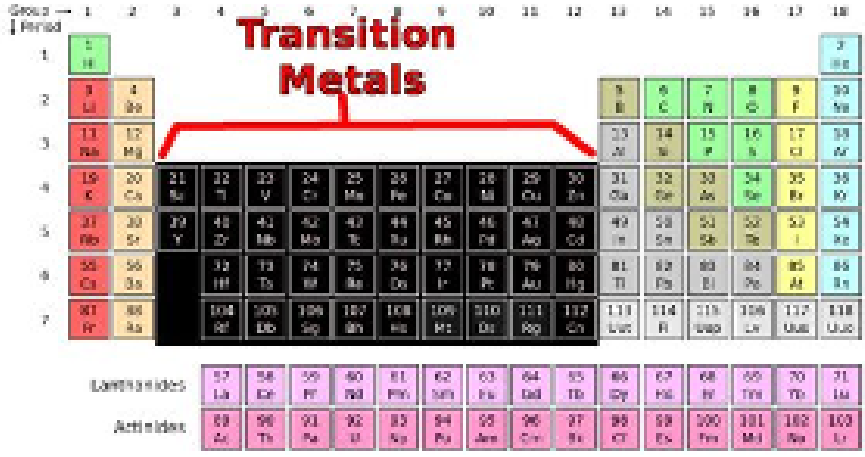
Dinitrogen monoxide = N2O (Since there is the prefix 'di' in front of the nitrogen ion we write it as N2. We notice that oxygen has the prefix 'mono' in front of it which means that there is only one oxygen in the compound so we just write 'O'.)

What is Ionic Bonding?

Ionic Bonding are bonds that are formed as a result of the transfer of electrons between the two elements in the compound. Ionic bonds can be formed by a bonding of a metal and a nonmetal element in the periodic table. The metals in the compound lose their electrons due to the low ionization energy whereas the nonmetals gain electrons due to the high electronegativity. For ionic bonds, a compound with a net charge of zero will be formed.



How do we write Ionic Bonds?



*Reminder:

If the metal is not a transition metal:

1. Rewrite metal as it is
2. Change suffix of the nonmetals to ‘ide’

Examples:

MgO = Magnesium Oxide (Magnesium is not a transition metal so we know the exact charge of Magnesium which is why we can write it as is and we change the ending of the oxygen ion by adding an “ide” at the end.)

NaCl = Sodium Chloride – Table Salt (Sodium is not a transition metal and we know the exact charge of Sodium so we write it as it is and change the ending of the chlorine ion and add an "ide")

If the metal is a transition metal:

1. Find charge of metal by identifying charge of the nonmetal
2. Using the charge of the nonmetal, balance out charge of the metal to get a net charge of zero
3. Write name of metal as is and write the charge of metal in roman numerals in parenthesis
4. Write name of nonmetal with the 'ide' ending

Examples:

FeO = Iron (II) Oxide (Since Iron is a transition metal, we do not know its exact charge so we need to find the charge of the oxygen. The charge of the oxygen based on the periodic table is negative two. We move the charge of the oxygen to the charge of the iron so we can balance it out. By doing so, iron will have gained a plus two charge and oxygen would be remaining at the negative two charge allowing the two charges to cancel out and get a net charge of zero. Now we can write the Iron as is and write its charge in parenthesis followed by the nonmetal with the 'ide' ending.)

Fe2O3 = Iron (III) Oxide (We see that there are three oxygen atoms in the compound so we figure out the its charge first as it's a nonmetal. Oxygen has a negative two charge and there are three of them so we need to multiply its charge by the number of atoms in the compound. We end up getting a charge of negative six by multiplying the charge of oxygen with the number of oxygens in the compound. Now we move on to the metal and see that there are two iron atoms in the compound. We need to do some simple arithmetic here in order to get a positive six charge for iron to balance it out with oxygen's negative six charge. We find that we need to multiply three with two in order to get a positive six charge for iron. This allows us to get a net charge of zero for the compound. Now we write down the formula by writing Iron as is and writing its charge of three in roman numerals in parenthesis and following it with Oxygen ending in 'ide'.)

Writing the formula for an ionic compound given its name:

If the metal in the compound is not a transition metal:

1. Identify the charges of both the metal and nonmetal using the periodic table
2. Switch the charges of the two elements and write them underneath the elements as subscripts and dismiss the charge

Example:

Aluminum Oxide = Al2O3 (We identify the charges of the metal and nonmetal and we switch the charges of the two elements and write them as subscripts while disregarding the positive and the negative charges of the charge.)

If the metal in the compound is a transition metal:

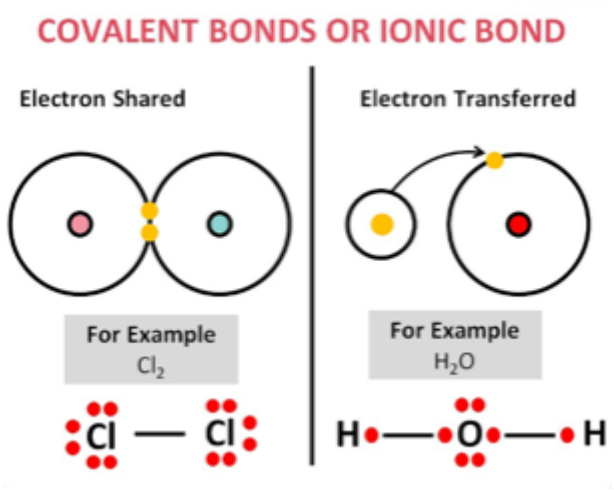
1. Look at the roman numerals and match that charge with the charge of the metal
2. Figure out charge of the nonmetal using the periodic table
3. Switch the two charges of the elements and write them as subscripts

Example:

Chromium (III) oxide = Cr2O3 (We see the roman numerals in parenthesis and correlate that number to be the charge of Chromium. Now we figure out the charge of the nonmetal which we find to be negative two. Now we switch the charges of the elements and write them as subscripts under their new respective elements.)

Covalent Bonding vs Ionic Bonding Summary (Conclusion):

As stated before, Covalent Bonding is the “sharing” of electrons between the elements in a compound and they occur between two nonmetals, whereas, Ionic Bonding is the “transfer” of electrons between elements in a compound and they occur between metals and nonmetals.



References for Diagrams:

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