Compounds and Chemical Bonding

Every day of our lives we are interacting with matter. From the oxygen in the air we breathe, to the clothing we wear and the food we eat, we use and depend on the matter around us (and believe me it really does matter). With a few exceptions, we're usually interacting with compounds or mixtures of compounds and not elements.

Compounds as you may recall, are types of pure substances composed of two or more different types of atoms that are joined together. For example, water, H_2O, is made from two atoms of hydrogen and one atom of oxygen. However there are a number of different ways that atoms can join together, and in doing so, cause the compounds to have different types of properties.

All types of chemical bonding involve the electrons in the outer shell of an atom. Atoms, like people, function best when they're stable. For an atom to be stable, it needs to have a completely filled outer shell of electrons. How the atom accomplishes this depends on what type of an atom it is as well as the type of an atom it will combine with. When atoms join together we say that they have bonded. This bonding is an attractive force that holds the atoms together. Some types of chemical bonds have a stronger attracting force between the atoms than other types of chemical bonds.

Covalent bonds occur when atoms share electrons between each other. Bonds that form between non metal elements are covalent bonds. Many covalent compounds are liquids or gases at room temperature which suggests that they have low melting and boiling points. Just like children that are told to share with their brothers and sisters, atoms may share electrons between themselves equally or unequally. If shared equally, the electrons spend an equal amount of time between the atoms. The result is a non polar molecule. An example of a non polar molecule is nitrogen gas . However, if the electrons are shared unequally, then one of the atoms gets to hold on to the negative electrons for a longer time then the other atom does. This causes its end of the molecule to develop a slight negative charge. The atom that does not get the electrons for as long a period of time, develops a positive charge. The result is a polar molecule. An example of a polar molecule is water.

Ionic bonds occur when some of the atoms in a molecule gain electrons while other atoms lose electrons. We call this a transfer of electrons. When an atom gains electrons it becomes negatively charged. Likewise when an atom loses electrons it becomes positively charged. Atoms that are electrically charged are called ions. As we found out when we studied static electricity, opposite charges attract each other. Oppositely charged ions attract each other and the bonds that hold them together are called ionic bonds. These ionic compounds are usually formed by bonding between a metal and a non metal, such as sodium chloride, NaCl. Most ionic compounds are crystalline solids at room temperature and have high melting points due to the strong force of attraction that hold the ions together.

Metallic bonding, as the name implies, is bonding that occurs between the atoms of metals. The outer shell electrons of metal atoms roam freely from one atom to another and are in constant motion. This results in positively charged metal ions surrounded by a moving " sea of electrons ". These moving electrons are why metals are good conductors of electricity and heat. They also explain other properties of metals, such as malleability, which is the ability to be hammered or rolled into sheets. Another important property of metals is ductility, which is the ability to be drawn into wire. With the exception of mercury which is a liquid at room temperature, all other metals are solids at room temperature. Most have high to very high melting points.

Types of Chemical Bonds

Type of Bond	Strength of Bond	Role of Electrons	Occurs between	Examples
Covalent	low	shared between atoms	non metals	water-H_2O carbon dioxide-CO_2
Ionic	very high	transferred between atoms	metals and non metals	sodium chloride-NaCl magnesium fluoride-MgF_2
Metallic	high to very high	shared amongst many atoms	metals	copper-Cu bronze-Cu+Sn brass-Cu+Zn