COMPOUNDS

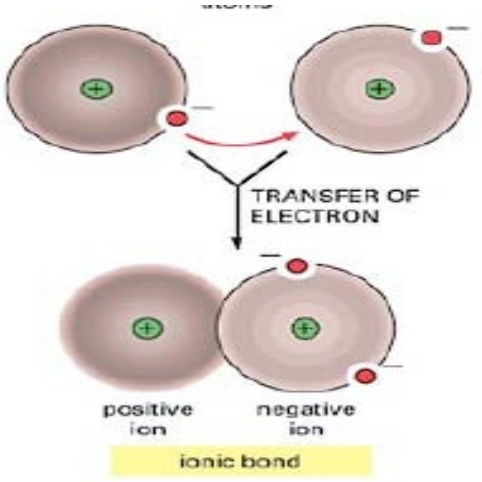
IONIC AND COVALENT BONDS

A **bond** is an attachment among atoms. Atoms may be held together for any of several reasons, but all bonds have to do with the electrons, particularly the valence electrons, of atoms. There are bonds that occur due to sharing electrons. There are bonds that occur due to a full electrical charge difference attraction. There are bonds that come about from partial charges or the position or shape of elements about an atom. But all bonds have to do with electrons. Since chemistry is the study of elements, compounds, and how they change, it might be said that chemistry is the study of electrons. If we study the changes brought about by moving protons or neutrons, we would be studying nuclear physics. Later in the unit we will see how, in chemical reactions, the elements do not change from one element to another, but are only rearranged in their attachments.

A **compound** is a group of atoms with an exact number and type of atoms in it arranged in a specific way. Every bit of that material is exactly the same. Exactly the same elements in exactly the same proportions are in every bit of the compound. Water is an example of a compound. One oxygen atom and two hydrogen atoms make up water. Each hydrogen atom is attached to an oxygen atom by a bond. Any other arrangement is not water. If any other elements are attached, it is not water. H_2O is the chemical formula for that compound. This formula indicates that there are two hydrogen atoms and one oxygen atom in the compound. H_2S is hydrogen sulfide. Hydrogen sulfide does not have the same types of atoms as water. It is a different compound. H_2O_2 is the chemical formula for hydrogen peroxide. It might have the right elements in it to be water, but it does not have them in the right proportion. It is still not water. The chemical formula is also used to mean the smallest bit of any compound. A **molecule** is a single formula of a compound joined by covalent bonds. The *Law of Constant Proportions* states that a given compound always contains the same proportions by weight of the same elements.

IONIC BONDS

An ionic compound is a group of atoms attached by an electrical charge difference that results from the loss or gain of electrons. When an atom loses electrons it becomes a positive ion because the number of protons exceeds the number of electrons. A positive ion, whether it is a single atom or a group of atoms all with the same charge, is called a **cation**. Some atoms, such as metals, tend to lose electrons to make the valence shell or outside ring of electrons more stable resulting in a positively charged atom (cation). Nonmetal elements tend to gain electrons to fill their valence shell resulting in a negatively charged atom (anion). When the number of electrons exceeds the number of protons, the ion is negative which we call an **anion**. *The attraction between a positive ion and a negative ion is an ionic bond.* Any positive ion will bond with any available negative ion; they are not fussy.

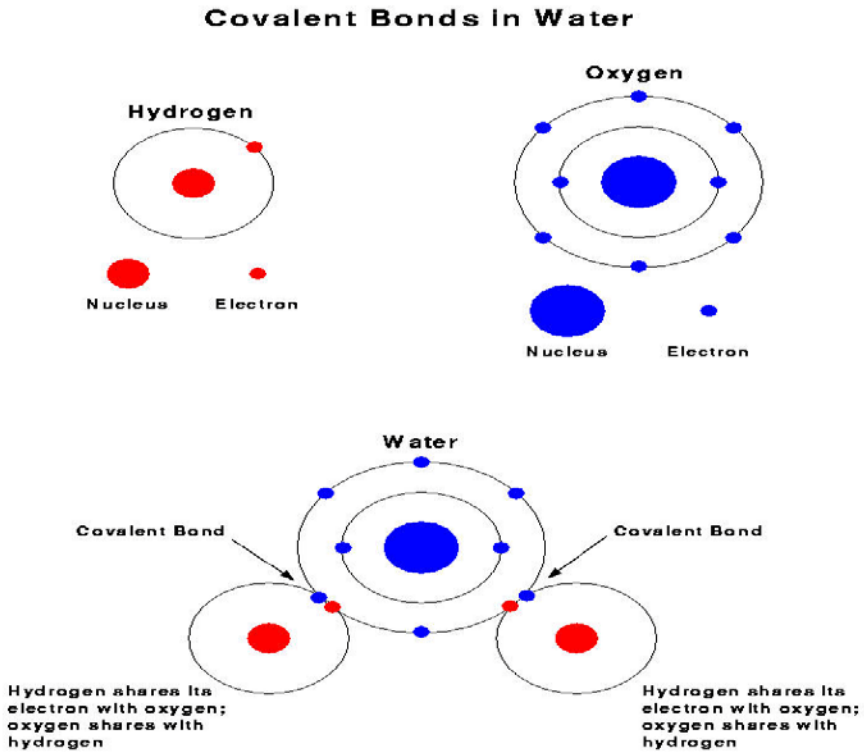


IONIC = CATION (metallic element) + ANION (nonmetallic element)

COVALENT BONDS

Covalent bonds are groups of atoms (typically a nonmetal and a nonmetal) joined by the sharing of a pair of electrons. The chlorine molecule is a good example of the bond, even if it has only one type of atom. Chlorine gas, Cl_2, has two chlorine atoms, each of which has seven electrons in the valence shell. Each atom contributes an electron to an electron pair that make the covalent bond. Each atom *shares* the pair of electrons, rather than transferring them to the other atom like in an ionic bond. In the case of chlorine gas, the two elements in the bond have exactly the same pull on the electron pair, so the electrons are exactly evenly shared. The amount of pull on an atom has on a shared pair of electrons, called **electronegativity**, is what determines the type of bond between atoms. Considering the Periodic Table without the inert gases, electronegativity is greatest in the upper right of the Periodic Table and lowest at the bottom left. The bond in francium fluoride should be the most ionic. There is a range of bond between purely ionic and purely covalent that depends upon the electronegativity difference of the atoms around that bond. If there is a large difference in electronegativity, the bond has more ionic character. If the electronegativity of each atom is more similar, the bond has more covalent character.

The covalent bond is much harder to break than an ionic bond. The ionic bonds of soluble ionic compounds *come apart* in water, but covalent bonds do not usually come apart in water. Covalent bonds make real molecules, groups of atoms that are genuinely attached to each other. Covalent bonds can come in double (sharing of two pairs of electrons) and triple (sharing of three pairs of electrons) bonds.



COVALENT = NONMETALLIC ELEMENT + NONMETALLIC ELEMENT

Answer the following questions on your own paper using complete sentences.

1. Why is chemistry sometimes called, “the study of electrons”?

2. Which electrons probably play the biggest role in bonding?

3. Why is hydrogen peroxide not considered the same compound as water?

4. Describe why cations and anions bond.

5. Are cations and anions picky about with whom they pair?

6. Describe what happens to electrons with a covalent bond.

7. Why are covalent molecules considered more strongly bonded?

8. How can you tell whether a compound has an ionic or covalent bond just by looking at what elements are involved?

9. How does electronegativity difference play a role in chemical bonding?

10. Nitrous Oxide (N_2O), methane (CH_4), carbon dioxide (CO_2), and chlorofluorocarbons (CF_2Cl_2, for example) are all common greenhouse gases and compounds we studied in our climate change projects. Label each as having either an ionic or covalent bond by using only their chemical symbols and your periodic table. How can you tell the difference between ionic and covalent bonds just by looking at chemical symbols?