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Summing-up

Every chemical bond is a force of attraction of electric type capable of uniting atoms and thus giving rise to substances. The electrons that determine the chemical properties of atoms are the valence electrons.

To represent the valence electrons it is useful to make use of **Lewis symbol diagrams**. For example, the Lewis symbol for phosphorus (element of group V) is written with 5 electron pinpoints surrounding the symbol P.

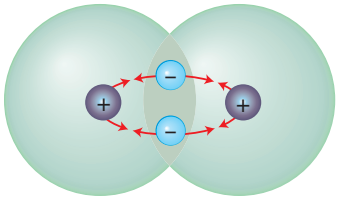
To predict what type and how many bonds can form between atoms, the **octet rule** is used, according to which the atoms tend to acquire, relinquish or share electrons to obtain an electronic configuration equal to that of the noble gases (with eight electrons in their valence shell).

Electronegativity also has to be taken into account, a property of atoms that gives an indication of the relative force with which an atom attracts bonding electrons.

There are three fundamental forms of chemical bonding: the *ionic bond*, the *covalent bond* and the *metallic bond*.

In the **ionic bond** the strength of attraction is due to the fact that the atoms that bind together are no longer neutral but have electric charges of opposite sign. These particles are called **ions**, and are obtained by transferring one or more electrons from the less electronegative to the more electronegative atom. For example, sodium and chloride bind with an ionic bond to form sodium chloride. A sodium atom is transformed into a Na^+ ion as it relinquishes its valence electron to the chlorine atom which is transformed into a Cl^- ion. In this way, both atoms reach the nearest noble gas configuration. *To write the formula of an ionic compound* it should be noted that the total number of positive charges of the cations must equal the total number of negative charges of the anions.

In the **covalent bond** the strength of attraction between two atoms is due to a shared pair of electrons.



The covalent bond can be represented with a hyphen that joins the symbols of the two bonded atoms, for example F—F.

From the octet rule, it can be predicted that they form two pairs of electrons shared between the two atoms in a covalent bond: a double bond (two pairs in common) or a triple bond (three pairs in common) are also possible.

When atoms that bind together with a covalent bond have different electronegativity the pair of shared electrons are more strongly attracted by the more electronegative atom and this leads to the formation of two electrical poles of opposite sign, this bond is therefore called a *polar covalent bond.*

A special type of covalent bond, which can be predicted on the basis of the octet rule, occurs when both electrons forming the covalent bond come from one of the two atoms: this bond is called a *dative bond*.

In the **metallic bond** all the atoms become positive ions as they give up their valence electrons which form a kind of "electron cloud" of negative charge. This electron cloud is mobile and capable of generating a force of attraction towards the positive ions of the metal.

Summing-up

Excluding materials that exhibit the metal bond, depending on the prevailing type of bond, substances can be classified into two categories: **ionic compounds** and **covalent substances**. When covalent bonds involve a known number of atoms molecules are obtained and the covalent substances formed by these particles are called **molecular substances**. However, there are also covalent substances consisting of an unspecified number of atoms that arrange themselves in regular geometric structures: these substances are known as **macromolecular substances**.

The different bonding models also help to explain the binding properties of various other substances.

In **ionic compounds** the attraction in all directions of the ions explains the fact that all ionic compounds are solid at room temperature, and their *fragility* can be explained as any relative movement of the ions brings into contact ions of the same sign that repel each other. Their *electrical conductivity* only in the liquid state is explained by the fact that the ions in this state are free to move.

For **molecular substances** the only property common to all is the inability to conduct electrically as the outer electrons are involved in the formation of covalent bonds.

In **metals** the electrical and thermal conductivity is explained by the free mobility of the bonding electrons. This mobility also explains their workable properties (*ductility* and *malleability*) in that relative movement of the atoms does not break the mutual ties.

For many elements, based on their location in the periodic table, predictions can be made about the type of bond that is formed when one element binds with another.