5 Classi, formule e nomi dei composti

Summing-up

Atoms demonstrate a precise capacity to bind with other atoms; this capacity is called valence: it *corresponds to the number of hydrogen atoms that can combine with an atom of the element*.

Even following new understandings of chemical bonds, chemists decided to give each atom present in any chemical species (molecules, simple ions and polyatomic ions) an **oxidation number (O.N.):** it is a conventional number, positive or negative, which corresponds to the number of electrons that the atom uses to form bonds with other atoms. It can take a positive or negative sign depending on whether the electronegativity of the atom of an element is respectively less than or greater than that of the atom of the element to which it is bound.

To determine the oxidation number of all the atoms of a given chemical species it is important to remember a number of practical rules:

1. atoms of pure elements have O.N. = 0;
2. oxygen atoms (except in OF_2 and peroxides) have O.N. = −2;
3. hydrogen atoms (except in metal hydrides) have O.N. = +1;
4. monatomic ions have oxidation numbers that coincide with their net charge;
5. the algebraic sum of the oxidation numbers of all the atoms present in the formula of a substance must be equal to zero, while in polyatomic ions it must coincide with the charge of the ion.

All compounds are grouped into specific classes, each with characteristic properties.

The **IUPAC nomenclature** establishes international rules to identify, in an unequivocal manner, the name of each compound in each class. Other rules are still in use, such as the *traditional nomenclature* that is closely related to the chemical properties of the classes of compounds.

The classes of compounds are as follows.

Oxides are binary compounds and can be obtained by reacting elements directly with oxygen: metal oxides (**basic oxides**) have chemical properties different from those of the non-metal oxides (**acidic oxides** or **anhydrides**).

Hydrides are binary compounds in which an element is combined with hydrogen. They are classified as *ionic* or *saline hydrides* (e.g. NaH), and *covalent hydrides* (e.g. PH_3)

Hydracids are binary compounds that consist of hydrogen and some nonmetals and that exhibit acidic properties in water.

Hydroxides are ternary compounds formed by hydrogen, oxygen and a metal; they can be obtained from the reaction of basic oxides and water. The formulas for hydroxides are distinguished by the fact that the symbol of the metal precedes the OH group, which is present in the formula with an index numerically equal to the O.N. of the metal. The hydroxides of alkali metals and alkaline earths exhibit basic character in water.

Oxoacids are ternary compounds composed of hydrogen, oxygen and a nonmetal; they can be obtained by reacting acidic oxides (or anhydrides) with water. The formulas for oxoacids are distinguished by the fact that the symbol of the nonmetal is located between those of hydrogen and oxygen, the indices of the formula are obtained by considering that the sum of the O.N.s of the atoms of the nonmetal and of hydrogen (all positive) must be equal and opposite to the negative value of the oxygen atoms.

$$\begin{array}{ccc} H & Cl & O_3 \\ | & | & | \\ +1 & +5 & -6 \end{array}$$

The salts are ternary compounds when derived from oxoacids and binary compounds when derived from hydracids: the formulas of the salts are derived from the formula

of an acid in which the symbol of a metal takes the place of the symbol for hydrogen; the indices of the formula are obtained knowing that the algebraic sum of the O.N.s of all the atoms in the formula must be zero.

The **neutralisation reaction** is the reaction between an hydroxide and an acid: the products are a salt and water. For example, with aluminum hydroxide and nitric acid it is:

$$Al(OH)_3(aq) + 3\ HNO_3(aq) \rightarrow Al(NO_3)_3\ (aq) + 3\ H_2O(l)$$

The reactions that take place between the various classes of compounds examined in this chapter can be divided into groups. The first fundamental distinction is as follows: *synthesis reactions* and *analysis reactions* (or *decomposition reaction*).

In **synthesis reactions**, two or more substances react to form a single product.

For example: $CO_2 + CaO \rightarrow CaCO_3$

Conversely, in **analysis reactions** two or more products are obtained from a single substance.

For example, $2\ NaClO_3 \rightarrow 2\ NaCl + 3\ O_2$

Other types of reactions:

- **exchange reactions**: an element replaces another element in a compound.
  For example, $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$;
- **double exchange reactions**: an element replaces another in a compound whilst, at the same time, the latter takes the place of the first element.
  For example:

$$AgNO_3(aq) + LiCl(aq) \rightarrow AgCl(s) + LiNO_3(aq).$$