Unit 3. The Chemical Bond

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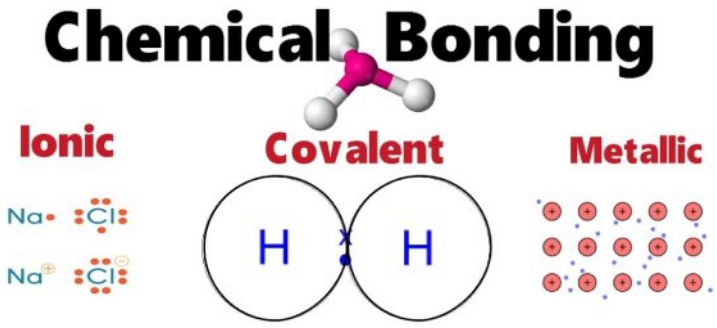
1 Introduction. Key Concepts



All chemical elements (except noble gases) combine with each other, because in this manner they are more stable.

- A **chemical bond** is an electrical attraction between atoms. Its purpose it is obtaining a stable electronic configuration (i.e, 8 electrons in the outer shell (**valence shell**), except for H and Li that are stable with two electrons in the outer shell.).
- **Valence** or **valency of an element** is the number of electrons that the element needs or exceeds to have a stable electronic configuration.

Noble gases

They are are called **inert gases** because they do not combine with any other atom, since they have and already **stable electronic configuration** in the valence shell.

Noble gases have **very low melting and boiling points**.

Types of chemical bonds

- **Covalent bonds**. Characterized by the **sharing of pairs of electrons** between **non-metallic atoms**.
- **Ionic bonds**. Characterized by the **loss of one or more of electrons** in **metallic atoms**, that are **gained** by a **non-metallic** atom.
- **Metallic bonds**. Characterized by the **sharing or loss pairs of electrons** between **metallic atoms**.

bond name	**covalent**	**ionic**	**metallic**
atoms involved	non-mettalic	metallic and non-mettalic	mettalic
description	sharing pair of electrons	loss of electrons in the metal, that are gained by the non-metal	losing or sharing electrons

2 The covalent bond

Chemical bonding that is characterized by the **sharing of pairs of electrons** between atoms of **nonmetals** or **hydrogens**.

2.1 Molecular covalent substances

Molecular covalent substances are chemical substances formed by **molecules**. A **molecule** is an electrically neutral group atoms held together by **strong covalent chemical bonds** in a **fixed number**.

2.1.1 Molecular formula

The molecular formula is the **symbolic representation** of its molecules. It shows:

- The **symbols** of the elements.
- The **numerical subscripts**, that indicate the number of atoms of each type.

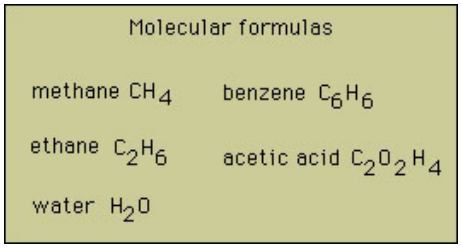


Figure 1: Examples of chemical formulas

2.1.2 Relative molecular mass

The relative molecular mass ,M_r, is the mass of one of its molecules. It is calculated by adding the atomic masses ,A_r, of the atoms that make up the molecule.

$$M_r(\mathrm{H_2O}) = 2 \times A_r(\mathrm{H}) + A_r(\mathrm{O}) = 2 \times 1 + 16 = 18\ u$$

2.2 Atomic covalent substances

Substances composed of millions of nonmetallics atoms joined by **strong covalent bonds** that form an **ordered 3D structure** called **crystal**.

Examples: C, diamond; C, graphite; SiO_2, quartz.

2.2.1 Empirical formula

Chemical symbols and their **numerical proportion** in the crystalline network.

3 The ionic bond

3.1 Ion formation

An **ion** is a **electrically charged atom** formed by the loss or gain of one or more electrons. The charge of an ion depends on the number of electrons that are gained or loss.

The net charge of an ion is writen in superscript afeter the chemical symbol of the atom. For example: Na^+, Ca^{2+}, S^{2-}.

According with their charge, ions can be:

- **anions**. If they have a negative charge.
- **cations**. If they have a positive charge.

3.2 The ionic bond

Type of chemical bonding formed through an **electrostatic attraction** between cations and anions.

The transfer of electrons occurs between millions of atoms, to form **ionic crystals**. Ionic compounds do not form molecules.

3.3 Examples of common ionic substances

- Common salt (NaCl).
- Fluorite (CaF_2).

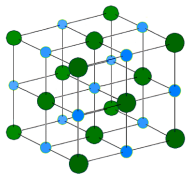


Figure 2: Ionic crystal

4 The metallic bond

Millions of metal atoms lose their outer electrons to form mettalic cations. These electrons are shared by the metal cations and form a "gas" of electrons that can flow around a three-dimensional and ordered network of millions of metallic cations.

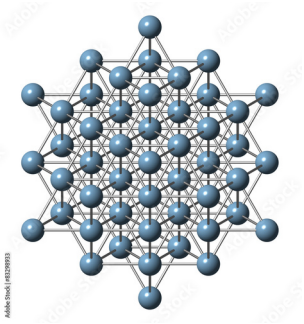


Figure 3: Metallic crystal