Chimica

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October 11, 2016

Chapter 1

Introduction

1.1 History of chemistry & basics

Chemistry studies the properties, the structure and the transformations of matter: it is a global science.

The structure comes from the "lattice": example, graphite vs. diamond.

Physical states of matter (everything which has mass and occupies space):

- Solid: fixed shape and volume
- Liquid: variable shape, fixed volume
- Gas: variable shape and volume

Matter: (smartlist) Mixes (can be separated) Homogeneous (ex: separation of methanol and ethanol) Heterogeneous Pure substances Elements Molecular Atomical (Composti) Molecular Ionic

Physical transformation: only the state or the look of the substance are changed. Physical properties: colour, odour, all that changes without the composition Chemical transformation: the composition is also changed. Chemical properties: they change when the composition changes.

Atomic theory Democritus, Plato and Aristotle, then a very late development (Mostly after 1800).

Of course, we use the scientific method.

Law of Conservation of Mass During a chemical reaction, matter cannot be destroyed nor created: it only changes form. So the total mass of the reactants is equal to the mass of the product.

Proust's Law Definite proportions

Dalton's Law The masses of a compound when it reacts with another to form different compounds have between then small rational ratios.

Atomic Theory The atomic number is the number of protons in an atom, denoted Z; the mass number is the sum of the protons and the neutrons, denoted A. A nuclide of the element E is denoted ${}^{\mathrm{A}}_{\mathrm{Z}}\mathrm{E}$ or E−A.

1.2 Measuring mass

Using kilograms is impractical, so we define the "uam" as equal to one twelveth of the mass of a ${}^{12}\mathrm{C}$.

Atomic mass is the weighted average of the isotopic masses.

The mass of a nucleus is usually less than the sum of the masses of the particles; this comes from the fact that $E = mc^2$.

Moles A mole is defined as N_A of something, where N_A is the number of atoms in 12 grams of ${}^{12}\mathrm{C}$.

$$N_A \approx 6.022\,141\,5 \times 10^{23} \tag{1.2.1}$$

Molar mass It is the mass (in grams) of a mole of something, expressed in g/mol. It is numerically equal to the atomic mass. So

$$MM = \frac{g}{n} \tag{1.2.2}$$

Metals Good conductors. They are usually oxidated when reacting with non-metals. They are usually solid at STP.

Metalloids Semiconductors. They act as (non-)metals when reacting with non-(metals).

Non-metals Usually di-atomic. Poor conductors. Exist in all states. The are usually reduced.

Divisions of the periodic table Groups are the columns in the periodic table, periods are rows.

Chapter 2

Molecules & compounds

2.1 Pure substances

We divide pure substances into elements (atomic or molecular) or compounds (molecular or ionic).

Molecular elements are usually diatomic, but sometimes (like in S_8) there are more atoms.

Types of formulas

- Minimal (brute formula): just the elements and the numerical ratios;
- Molecular: the elements and the exact number of each atom. To get it we need the molecular mass of the compound;
- Structural: the elements, their number, how they are placed in space and their bonds;
- Molecular models: spheres and sticks, or "full" molecular models where the atoms fill the spaces;
- Sterical formula: from VSEPR theory, VB and OM.

2.2 Ionic compounds

They are formed by an anion (usually a non-metal) and a cation (usually a metal). We need a "unit formula", with the types of ions and their ratios. Ions are atoms with nonzero electric charge.

To form cations or anions we have reactions like:

$$\mathrm{X} \longrightarrow \mathrm{X}^{\mathrm{n}+} + \mathrm{n}e^- \tag{2.2.1}$$

$$\mathrm{X} + \mathrm{n}e^- \longrightarrow \mathrm{X}^{\mathrm{n}-} \tag{2.2.2}$$

Atoms in the 1A-3A groups form ions with charge equal to their group number (their extra electrons). Non-metals usually form ions with charge equal to eight minus their group number (the electrons they are missing).

There are also polyatomic ions (like CO_3^{2-}).

To do: learn all the polyatomic ions. They are all negative, except for NH_4^+.

When an ionic compound forms, its total charge is always 0: this is useful when balancing reactions and finding formulas.

We always write the cation first and the anion last. We should only speak of the "formula mass" of an ionic compound.

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