

Chemistry: The Study of Matter and the Changes that Matter undergoes and The Energy Associated with The Changes

Analytical chemistry is a measurement science consisting of a set of powerful ideas and methods that are useful in all fields of science, or

Analytical chemistry: deals with the determination of composition of materials-that is, the analysis of materials

Analytes are the components of a sample that are to be determined.

Qualitative analysis discovers the identity of the elements and compounds in a sample.

Quantitative analysis indicates the amount of each substance in a sample.

Gravimetric methods are quantitative methods that are based on determining the mass of a pure compound to which the analyte is chemically related.

Volumetric method involves measuring the volume of a solution of known concentration (standard) that is needed to react completely with the analyte.

. A solution is composed of:

- the solute: the minor component (least number of moles)
- the solvent: the major component (largest number of moles)

2. Soluble / Insoluble: A soluble substance readily dissolves in the solvent. An insoluble substance will NOT dissolve readily in a solvent.

3. Miscible / immiscible: Two liquids are miscible in each other if they readily mix to form a uniform solution. Two immiscible liquids will always separate out into two distinct layers.

Aqueous-solution Reactions classify a reaction by

Homogeneous chemical reactions:

gas phase

solutions: aqueous-solution (common occurrence)

non-aqueous-solution

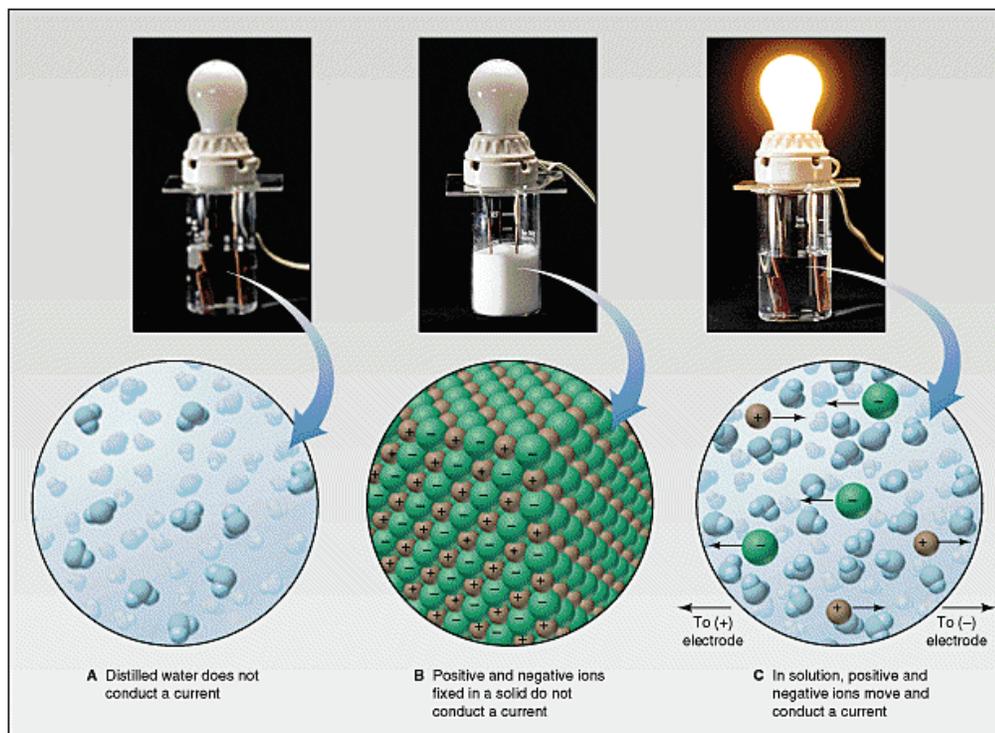
Heterogeneous (more than one phase) chemical reactions:

- gas / liquid
- gas / solid
- liquid / solid

Nature of Aqueous Solutions

Nature of compounds: molecular substances (polar, non-polar, H-bonding) non-electrolytes

ionic substances (acids, bases, salts) strong electrolytes (completely ionized in solution) weak electrolytes (not completely ionized in solution)



Strong Electrolytes

Strong acids:  $\text{HNO}_3$ ,  $\text{H}_2\text{SO}_4$ ,  $\text{HCl}$ ,  $\text{HClO}_4$

Strong bases:  $\text{MOH}$  ( $\text{M} = \text{Na}, \text{K}, \text{Cs}, \text{Rb}$  etc)

Salts: All salts dissolving in water are completely ionized

Types of Chemical Reactions

1- Neutralization Reactions (Acid-Base Reactions)

2- Oxidation-Reduction (Redox) Reactions

a. Redox reactions are by far the most important type of reactions.

b. Redox reactions involve the transfer of electrons from one species to another.

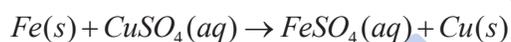
c. *Oxidation* is defined as the loss of electrons.

d. *Reduction* is defined as the gain of electrons.

Oxidation and reduction always occur simultaneously, since the electrons lost in the Oxidation must go somewhere

◆ The reaction of an iron nail with a solution of copper(II) sulfate,  $\text{CuSO}_4$ , is an oxidation-reduction reaction

◆ The molecular equation for this reaction is:



- The species that is reduced itself causes another species to be oxidized and is therefore known as the oxidizing agent.
- Similarly, the species that are oxidized causes another to be reduced and is therefore known as the reducing agent.

### Oxidation Numbers

◆ The concept of oxidation numbers is a simple way of keeping track of electrons in a reaction.

◆ The *oxidation number* (or oxidation state) of an atom in a substance is the actual *charge* of the atom if it exists as a monatomic ion.

◆ Alternatively, it is *hypothetical charge* assigned to the atom in the substance by simple rules.

**Table 4.5** 

**Rules for Assigning Oxidation Numbers**

Rule	Applies to	Statement
1	Elements	The oxidation number of an atom in an element is zero.
2	Monatomic ions	The oxidation number of an atom in a monatomic ion equals the charge on the ion.
3	Oxygen	The oxidation number of oxygen is $-2$ in most of its compounds. (An exception is O in $H_2O_2$ and other peroxides, where the oxidation number is $-1$ .)
4	Hydrogen	The oxidation number of hydrogen is $+1$ in most of its compounds. (The oxidation number of hydrogen is $-1$ in binary compounds with a metal, such as $CaH_2$ .)
5	Halogens	The oxidation number of fluorine is $-1$ in all of its compounds. Each of the other halogens (Cl, Br, I) has an oxidation number of $-1$ in binary compounds, except when the other element is another halogen above it in the periodic table or the other element is oxygen.
6	Compounds and ions	The sum of the oxidation numbers of the atoms in a compound is zero. The sum of the oxidation numbers of the atoms in a polyatomic ion equals the charge on the ion.

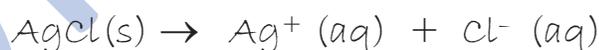
### 3- Precipitations:

When ions form a solid that is not very soluble, a solid is formed. Such a phenomenon is called precipitation.

The formation of a precipitation is also an equilibrium phenomenon



or



$$K_{sp} = [Ag^+][Cl^-] \text{ is a constant}$$

↑ the solubility product

### 4- Complex formation reactions