

Mixtures & solutions

- 1.- Mixtures
- 2.- Heterogeneous mixtures
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1.-Mixtures

A **mixture** is a sample of matter which is formed by two or more different components which are not bound and without any fixed proportions to each other. For instance, if you look at a granite rock, you can easily distinguish between a gray portion, some black dots and some crystals which reflect the light. Granite is a mixture composed by quartz, feldspar and mica. Almost everything you can find is a mixture because even a pure substance, such as distilled water, have few impurities, such as salt.

On the other hand, a **phase** is a portion of homogeneous matter which is uniform throughout. In other words, it has the same appearance and physical properties everywhere.

2.- Heterogeneous mixtures

On a general basis, we can classify mixtures into two different types: heterogeneous and homogeneous mixtures.

A **heterogeneous mixture** is one which has visibly several portions of matter or phases of different appearance. In other words, in a heterogeneous mixture we can see a boundary or a surface which separates at least two different portions. For instance, a vinegar and oil salad dressing is a heterogeneous mixture because we can see a layer of oil at the top of the mixture and a vinegar one at the bottom, which let us distinguish them easily. Other examples of heterogeneous mixtures are the beach sand, which have particles of different colours, cereals in milk, or water and steam inside a pressure cooker. Remember that *the prefix "hetero-" means difference*.

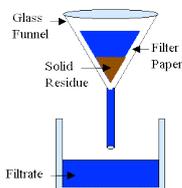
Activity 1: Classify some of these mixtures into homogeneous and heterogeneous: granite, wine, coke, a sample of soil, air with dust, sea water, apple juice

Activity 2: Try to explain why the oil splashes when some drops of water fall into the pan

Furthermore, these portions have different physical properties (e.g. boiling point, colour, etc..) and consequently they can be easily isolated using separating methods which don't change the state of the sample. These methods are called **physical separation methods**, because no chemical processes are involved. The most important physical separation methods are:

1. Magnet separation

If one of the components of the mixtures has magnetic properties (e.g. iron, nickel, etc.) and the other not, we can use magnet separation. A magnet attracts the portions of iron and the rest can be discarded



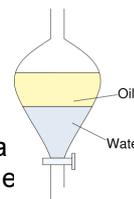
1. Filtration

We use filtration to separate an insoluble solid from a liquid. For Instance, a mixture which consists of sand and water can be separated pouring all the mixture through a filter paper placed in a funnel.



1. Decantation (separating funnel)

Two immiscible liquids which have different densities can be separated by decanting using a separating funnel. First, we pour the mixture in the separating funnel. Then we have to wait some minutes until a clear separation boundary is formed. Finally, we drain the heavier phase in a beaker or erlenmeyer flask. Decanting is an alternative separation technique an insoluble solid and liquid mixture, but less suitable than filtering

**1. Liquid extraction**

It is used for separating a substance which has different solubility in two immiscible liquids, usually water and an organic solvent. When we mix both solvents, the substance goes from one liquid to the other and then we have to decant them with a separating funnel

1. Centrifugation

This technique is a kind of sedimentation produced by the centrifugal force in a centrifuge. The densest components of the mixture move away along the axis of the centrifuge and the lightest components remain at the top of the solution

3.- Homogeneous mixtures

A **homogeneous mixture** is one which has the same appearance everywhere, or, in other words, it consists of just one phase. Consequently, it's impossible to recognize the components of the mixture by naked eye. Wine, air or a steel alloy are some examples of homogeneous mixtures. Remember that the prefix "**homo-**" means sameness.

A homogeneous mixture has the same composition and physical properties throughout. It has its own value of different physical properties which depends just on its composition. For instance, hardness of steel is quite different than iron's one and depends just on the composition of carbon in the alloy.

Homogeneous mixtures are not so easy to separate as heterogeneous ones, so we usually need to change some of the features of the sample, such as its state of matter, etc. The most important separation methods for homogeneous mixtures are:

1. Distillation

Distillation is a separation process of the components of a mixture of two components which have different boiling points. The mixture is heated until it reaches to the lower boiling point. Then, one of the substances becomes vapour and can be separated. This vapour is cooled until it condenses and is collected in a vessel.

2. Crystallisation

Crystallisation is the process of formation of a solid crystal in a liquid solution because the solvent has been evaporated. When all the liquid has been evaporated, the solid crystals remain at the bottom of the vessel.

3. Paper chromatography

It is used to separate several organic substances which travel through the chromatography paper at different speeds. A little amount of mixture is placed at the bottom of the paper strip in contact with an organic solvent. The polar substances contained in the mixture are bound to the paper more tightly, so they travel less distance through the paper strip

Activity 3: Try to establish which separation technique can be used in these mixtures: ink formed by different dyes, water and salt, sulphur and iron, sand and copper sulphate



4.- Solutions

We also use the term **solutions** to call a homogeneous liquid mixture. Generally speaking, solutions are formed by two components, solut and solvent. **Solut** is the component of the solution present in the lesser amount, whereas **solvent** is the component found in the greater amount

Sometimes the distinction between homogeneous and heterogeneous mixtures is not so obvious. As a matter of fact, it depends on the size of the particles and the separation method used to isolate their components. Generally speaking, we can distinguish between suspensions, colloids and actual solutions.

A **suspension** is a mixture with large particles, whose size is greater than 1 μm , so they are visible by naked eye. A suspension is a heterogeneous mixture which can be filtered or decanted and eventually settled. An example of suspension is a mixture of fine sand in water or the dust particles floating in the air.

Colloids are heterogeneous mixtures whose particle size are between 1 and 1000 nm . They cannot be completely separated by filtering, although some of the particles are retained in the filter. Their particles can be detected by the scattering of light when it crosses through the mixture. This property is called **Tyndall effect**. Some examples of colloids are milk or some juices.

Finally, actual solutions have particles whose size is similar to atoms or molecules, less than 1 nm. They cannot be filtered or decanted and do not show Tyndall effect.

5.- Concentration and solubility

Composition of a solution is the relative amount of solute in the mixture. We can prepare solutions according to the proportion we have already chosen. In other words, solutions have variable composition and the properties of a solution depend just on its composition. Consequently, if we want to describe a solution, we have to know their components and its composition.

Composition of a solution can be expressed in different ways:

1. **Mass percent**

Mass percent is the ratio of the mass of solute to the total mass of the solution multiplied by 100

2. **Volume percent**

Volume percent is the ratio of the volume of solute to the total volume of the solution multiplied by 100

3. **Mass-volume concentration**

Concentration of a solution is the mass of solute per unit volume of solution

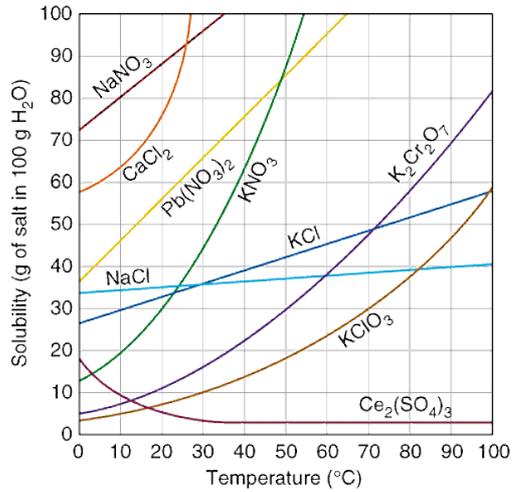
$$C = \frac{m_{\text{solute}}}{V_{\text{solution}}}$$

It is usually expressed in grams per litre.

On a general basis we can classify solutions into diluted, concentrated and saturated. A solution is **diluted** if it contains a little amount of solute. On the other hand, a solution is **concentrated** if it contains a greater amount of solute. A **saturated** solution is one in which we cannot solve an extra amount of solute. In other words, a saturated solution contains the maximal amount of solute per unit volume of solution.



Solubility is the maximal amount of solute which can be solved per unit volume of solution. In other words, it is the concentration of solute in a saturated solution. On a general basis, solubility depends mainly on temperature and pressure.



In general solubility increases as temperature increases, but this is not a rule because we can find substances that have the same solubility or even less solubility as temperatures increases

