**1.1 What is this chapter about?**

When you put two substances together, there is a chance that the substances will mix. There might be a chemical reaction. In a chemical reaction, substances disappear and are replaced by other substances.

**1.2 What happens when substances mix?**

Solids with water:

Every solid substance does something different with water. Calcium reacts with water to make chalk and hydrogen gas. You can express this as follows in a chemical equation:

Calcium + Water -> Chalk + Hydrogen

Sugar and chalk both mix with water, but in different ways. The sugar dissolves. A solution is formed. Water is called the solvent. The substance that dissolves (the sugar) is called the solute. This is called a homogeneous mixture.

Chalk does not dissolve. Small pieces of chalk remain suspended in the water. A suspension is formed. This is called a heterogeneous mixture. The substances are not thoroughly mixed.

Some liquids like alcohol and gases like ammonia also dissolve very well in water. They produce clear liquids. Not all solutions have water as a solvent. In oil paint, the solvent is turpentine.

**Substance A + Substance B = - Mixture (heterogeneous or homogeneous)**

**- Nothing**

**- Chemical reaction**

Mixtures and molecules:

Almost all the substances are made up of very small particles called molecules. If you dissolve sugar I water, the sugar molecules become free from each other and spread themselves out among the water molecules.

A solution is a homogenous mixture and always clear, you can see through it.

Not all solid substances dissolve well in water. Chalk remains suspended in water as small particles. A suspension is a heterogeneous mixture, it is always cloudy: you cannot or can hardly see through it.

All gases mix together homogeneously, that’s because of the vast amount of space between the gas molecules. Air is an example of this.

Mixtures of solid substances never give a homogeneous mixture.

**A solution is a homogeneous mixture of a substance (a solute) and a solvent, usually water. The substances are thoroughly mixed at molecular level. A solution is always clear.**

**A suspension is a heterogeneous mixture of a solid substance and a liquid. The substances are not thoroughly mixed. A suspension is always cloudy.**

**1.3 More heterogeneous mixtures**

Solid in gas:

Some is a heterogeneous mixture which consists of small, solid particle of matter. These particles that remain suspended in air are usually dangerous.

Liquid in liquid:

Mayonnaise, sun tan cream and other creams are all heterogeneous mixtures.

Oil and water mix together poorly, they form two layers of liquid. During shaking the oil is the broken up into small droplets, which float in the water. Such a heterogeneous mixture of two liquids is called an emulsion. This emulsion will not exist for long, as the oil will start to float back on the water after a couple of minutes. The substance used to stabilize the emulsion is called an emulsifier.

Liquid in gas:

A liquid, finely divided into a gas, is called a mist. You observe a mist when using spray deodorant or hairspray.

Gas in liquid:

The sensation on your tongue of cola is caused by dissolved carbon dioxide gas. Some of these bubbles remain trapped and form foam.

Gas in solid:

A heterogeneous mixture of gas that is trapped in a solid material is also called foam. Well-known examples of this are polystyrene foam and foam rubber.

**Name: Heterogeneous mixture of:**

**Smoke Solid in a gas**

**Emulsion Two liquids**

**Mist Liquid in a gas**

**Foam Gas in liquid of in solid.**

**1.4 Concentration**

The concentration shows how ‘strong’ a mixture is. Syrup mixtures with the same concentration have exactly the same color and the same flavor. It does not matter if you have a little or a lot of such a mixture.

A mixture can have all levels of concentrations. The concentration (also called the content) is the amount of a substance per unit amount of mixture. You can speak of e.g. the concentration of sugar in jam or the concentration of alcohol in drinks.

Concentration has a value and a unit. It is often expressed in grams per

liter (g/L). There are also other units of concentration, e.g. percent. A wine bottle is labeled 12 % vol (percent by volume).

**The concentration is the amount of a substance per unit amount of mixture. Concentration is given in grams per liter, percent by volume or percent by mass.**

**1.5 Calculation with concentrations**

Read pages 19-23 and do the exercises.

Calculations with concentrations can be done in three ways:

* Using the formula for concentration
* Using ratios
* Using a graph

**1.6 More about solubility**

You can easily dissolve 1 g salt in 100 mL water. The solution you obtain is called unsaturated, because a lot more salt could be dissolved. As soon as solid table salt remains on the bottom, the solution is called saturated. The maximum amount of a substance that can be dissolved is called the solubility of that substance.

Solubility also depends on the temperature. At higher temperature, more oxalic acid can dissolve. The solution is unsaturated: no solids lie at the bottom. Upon cooling the solubility decreases. The solution becomes saturated and the ‘extra’ oxalic acid crystallizes out, an attractive phenomenon.

Solubility is usually given in grams of solute per liter of solvent. The solubility of table salt in water at 25 \*C is 359 g/L. The temperature is given because it depends on that.

**The solubility of a substance (solute) is the maximum amount of that substance, in grams, that can be dissolved in one liter of solvent. Solubility depends upon the type of solute, the type of solvent and the temperature.**

**An unsaturated solution is a solution in which more solute can be dissolved.**

**A saturated solution contains the maximum quantity of dissolved substance.**

How quickly does the solute dissolve?

You can speed up dissolving a solid substance by stirring, by powdering the substance and by heating. Heating also changes the solubility.

**1.7 Calculations with small concentrations**

With substances that occur in very small concentrations, it is not useful to give the concentration in grams per liter or as a percentage. In this case units such as mg/m3, ppm by mass and ppm by volume are used. The abbreviation ppm means parts per million. So, 6ppm by mass chlorine in swimming pool water means that here are 6 grams of chlorine in one million grams of swimming pool water.

In air only exceedingly small concentrations of harmful substances are permitted. A MAC-value has been established for all sorts of substances. MAC stands for Maximum Allowable Concentration. The MAC value changes from substance to substance.

**At low concentrations the units used are mg/m3, ppm by mass and ppm by volume. It means parts per million. MAC means Maximum Allowable Concentration.**