

Chemistry (Math Notes)

Module #10

TERMS

A solute is the substance that is dissolved.

A solvent is the substance that the solute is dissolved in.

A solution is the solute + the solvent.

Solubility refers to the maximum amount of solute that can be dissolved in a given amount of solvent.

A saturated solution is a solution in which the maximum amount of solute has been dissolved.

Precipitation is the process by which a solid solute leaves a solution and turns back into its solid phase.

Exothermic is a process that produces heat.

Endothermic is a process that absorbs heat.

Water is a common solvent because more substances can be dissolved in it than in solids, even gases can be dissolved in water.

Example:



Why? Because all ionic compounds dissolve by splitting into ions. Covalent compounds don't break up into ions, but the water molecules surround these compounds.

Example:

Sugar- covalent

Salt- ionic

Rules of Solubility

1. The solubility of an solute depends both on the identity of the solute *and* the identity of the solvent. **(Be sure to understand and remember the facts in Table 11.1 –p.358)**
2. For solid solutes, solubility increases with increasing temperature. (*Direct relationship*)
3. For fluid solutes, solubility is not affected by temperature. (*No relationship*)
4. For gas solutes, solubility decreases with increasing temperature. (*Inverse relationship*)
5. Increasing pressure increases the solubility of gasses. (*Direct relationship*)
6. Pressure does not affect the solubility of solids and liquids. (*No relationship*)

FORMULAS:

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{Liters of solution}}$$

$$\text{Molality (m)} = \frac{\text{moles of solute}}{\text{Mass of solvent}}$$

When a solute is dissolved in a solvent, the resulting change in the freezing temperature is determined by the following formula:

Define Freezing Point Depression: when the adding of solutes lowers the freezing point of a solvent.

Define Boiling Point Elevation: when adding of a solute increases the boiling point of the substance.

When a solute is dissolved in a solvent, the resulting change in the boiling point temperature is determined by the following formula:

What is a Solution? How do You Saturate A Solution?

Each solution is a mixture of sugar (sucrose) and water. Sugar is the solute and water the solvent. Solution A has twice as much sugar added to the same amount of water as does solution B. Thus, Solution A is more concentrated than is Solution B. You can also say that of the two solutions, A and B, Solution B is more dilute.

A **solution** is a **homogeneous mixture**, meaning it is the same throughout. A solution can be made of more than two substances, with one of the substances being the **solvent** and the substances that dissolve in the solvent are called **solutes**.

You make and use chemical solutions every day. Add sugar to your cereal or tea and you have made a solution. Put on any cologne or perfume and you are using a solution. While the examples on this page use water as the solvent, there are many different kinds of solvents—ethyl alcohol is the solvent in colognes and perfumes.

How Does A Solution Form?

A solution forms when a **solute** dissolves in a **solvent**, which means the solute breaks apart and disperses equally throughout the solvent. Adding sugar to water is an example of making a solution because the sugar (solute) will dissolve in the water (solvent).

The **concentration** of a solution depends on the ratio of the amount of solute to the amount of solvent. If the amount of solvent remains constant, then the concentration of the solution is a function of the solute. This means that any change in the amount of solute affects the solution's concentration. This could be expressed as:

$$C(\text{solute}) = \text{amount of solute} / \text{amount of solvent}$$

Read as: A Solution's concentration as a function of solute is the ratio of amount of solute to amount of solvent.

Dilute refers to a low concentration. Dilute is not a quantitative term, instead it is more qualitative, meaning descriptive. Dilute refers to having a small amount of solute in a large amount of solvent. Small and large are also descriptive terms. How small? How large? My point is that saying a solution is dilute doesn't give enough information unless you are comparing it to

something else. For example, if you prepare two solutions as shown in the diagram, you could say that solution-A is more dilute than is solution-B.

Other qualitative descriptions for solution concentration include saturated solution and super saturated.

The graph shows that more sucrose (table sugar) dissolves in water as the temperature of the water increases. The graph also show that while more sodium chloride (table salt) dissolves in water as the temperature of the water increases, the increase is very small.

A **saturated solution** is made by dissolving as much solute as possible in a solvent. For example, add table sugar (solute) to a glass of water (solvent) until no more sugar will dissolve even with vigorous stirring. The undissolved sugar settles to the bottom of the glass. The amount of sugar that dissolves depends basically on the amount of water and its temperature.

Look at the Solubility Graph for Sucrose and Sodium Chloride. The dark line representing the solubility of sucrose – sugar at different temperatures curves upward. The red line representing the solubility of salt-sodium chloride only slightly rises. Thus, while an increase in temperature greatly affects the amount of sugar that will dissolve in water, there is very little affect on the solubility of salt.

A **supersaturated solution** of sugar could be formed by heating the solution to the boiling point of water, which is 100^o C. The solubility graph shows that at this temperature, about 475 g of sugar will dissolve in 100 g of water. When all the

sugar has dissolved, the solution is allowed to cool. At any temperature lower than 100° C, the solution is considered supersaturated. This is because the solution has more solute dissolved in the solvent than normally dissolves at the lower temperature.

Supersaturated solutions are unstable and stirring or jostling the solution can cause the excess dissolved sugar molecules to begin to stick together forming crystals when are said to **precipitate**. Precipitate means to “fall out of solution.”