

## Objective 4 Factors Effecting Solubility

1. Demonstrate how various factors influence solubility including temperature, pressure and nature of the solute and solvent

When sugar is dissolved in water the resulting mixture is homogeneous because the sugar is evenly (or uniformly) distributed among the water (sometimes referred to as “degree of mixing”). This homogeneous mixture is called a solution. A solution has two components:

- i. solute – dissolved substance, what gets dissolved (the sugar).
- ii. solvent – what does the dissolving, what dissolves the solute (the water).

Any solution where water is the solvent is called an aqueous solution.

### Factors Effecting Solubility

#### Temperature

As the *temperature* goes up, *most* solid salts increase their amount that can be dissolved. Gases do the opposite → as the temperature of the solution goes up, the amount of gas that can be dissolved decreases. This explains why warm soft drinks go flat faster (less gas can be dissolved) and why fish can live in lakes that have frozen over (as the water got colder, the amount of oxygen dissolved increase).

#### Pressure

For gases, the solubility of all gases in liquids increase with increases in pressure. The higher the pressure of a gas above a solution of that gas, the more gas will dissolve in the solution (i.e. CO<sub>2</sub> over the surface of Dr. Pepper → more CO<sub>2</sub> gas over the top of the surface, more CO<sub>2</sub> in the Dr. Pepper). Pressure has very little effect on the solubility of solids and liquids.

#### Likes Dissolve likes

The nature of the solvent and the solute has a great deal to do with the formation of solutions. The general statement “likes dissolves like” is used to help remember how solutes and solvents interact. It refers to the type of bonds in the solute and the solvent. Ionic solutes dissolve in ionic solvents, and covalent solutes dissolve in covalent solvents. Gasoline is non-polar covalent and it does not mix well with water (very polar solvent), hence, the old saying “oil and water don’t mix!”

#### Factors Effecting amount of solute that will dissolve:

##### Solid dissolving in liquid:

- Increase temperature usually increase solubility

##### Gas dissolving in liquid

- Increase pressure increase solubility
- Increase temperature decrease solubility

#### Factors Increase rate of dissolving a solid in a liquid

- Increase Rate:
- Increase temperature
- Stirring
- Crushing solid

#### Amount of solute in Solutions can be describe as:

- 1) saturated

- a) Exactly the maximum amount of solute that will dissolve at any given temperature.
  - b) Adding more solute causes the extra solute not to dissolve and to sit at the bottom of the solution.
- 2) unsaturated
- a) There is less solute dissolved than the solution can hold at any given temperature.
  - b) Adding more solute causes the extra solute to dissolve.
- 3) supersaturated
- a) Under special conditions, there can be more solute dissolved than normally would be at a given temperature.
  - b) Adding more solute will cause a large amount of solute to settle out and fall to the bottom of the container.
  - c) These are very unstable solutions and can easily be disturbed by shaking or by adding a crystal of the solute to them.

Measurement of solubility is usually expressed in grams of solute per 100 grams of solvent at a given temperature. To show the solubility of a solute in a particular solvent at various temperatures is usually shown in a solubility curve. The curve can have many different solutes on it. Remember, as temperature increases, the amount of gas dissolved decreases, thus, their graphs will have a large curve sloped down and to the left. Most other substances will increase in solubility as the temperature goes up, thus, curving up and the left.

The 100 grams of solute is very important and the students might have to make a proportional type problem out the information to solve a problem.

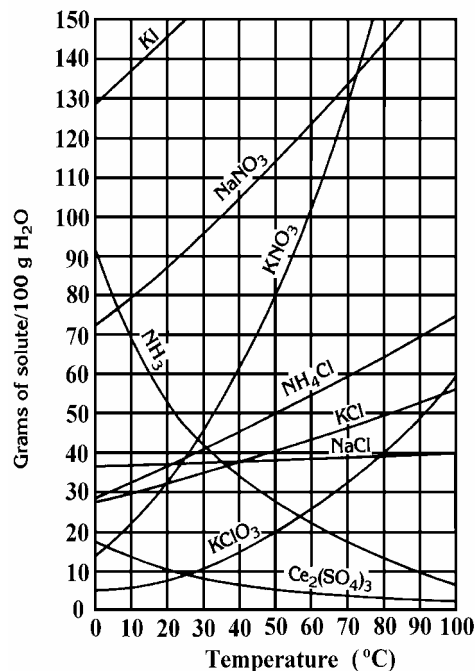
**Example:**

A student tested the solubility of salt at different temperatures and then used a graph from a different experiment as a reference table to identify the salt. The student's data table is shown below on the left, with the graph of solubility curves for different salts on the right.

Temperature °C	grams of salt per 10 grams of water
30	1.2
50	2.2
62	3.0
76	4.0

What is the identity of the salt?

- (a) potassium nitrate,  $\text{KNO}_3$
- (b) sodium chloride,  $\text{NaCl}$



(c) potassium chlorate,  $\text{KClO}_3$

(d) ammonium chloride  $\text{NH}_4\text{Cl}$

Answer: Since this is for 10 grams of water you need a proportion to solve this problem. I will pick  $62^\circ\text{C}$  (I could pick any one of them).

$$\frac{3.0 \text{ grams salt}}{10 \text{ grams H}_2\text{O}} = \frac{X \text{ grams salt}}{100 \text{ grams H}_2\text{O}} = 30 \text{ grams of salt.}$$

Now read the graph and find the point 30 grams of salt @  $62^\circ\text{C}$  and the closest one there is  $\text{KClO}_3$ . Also, notice how much  $\text{NH}_3$  drops as the temperature goes up... indicates that  $\text{NH}_3$  is a gas.