

## Characteristics of Solutions:

Solutions are **homogeneous** mixtures containing two or more substances called the **solute** and **solvent**.

The **solute** is the substance that dissolves.

The **solvent** is the dissolving medium. When looking at a solution it is **impossible** to distinguish the solute from the solvent.

A solution can exist as a solid, liquid or gas depending on the **state** of the solvent.

### Types of Solutions and Examples

Type of Solution	Example	Solvent	Solute
<b>GAS</b>			
Gas in gas	Air	Nitrogen(gas)	Oxygen (gas)
<b>LIQUID</b>			
Gas in liquid	Carbonated water	Water(liquid)	Carbon dioxide(gas)
Liquid in liquid	Vinegar	Water (liquid)	Acetic acid (liquid)
Solid in liquid	Ocean water	Water(liquid)	NaCl(solid)
<b>SOLID</b>			
Liquid in solid	Dental amalgam	Silver(solid)	Mercury(liquid)
Solid in solid	Steel	Iron(solid)	Carbon(solid)

Remember that a substance that dissolves in a solvent is said to be **soluble** in that solvent.

A substance that does not dissolve in a solvent is **insoluble**.

Two liquids that are soluble in each other are said to be **miscible** such as **water and vinegar, coffee and cream**

Liquids that are not soluble in each other are **immiscible** such as **vegetable oil and vinegar, gasoline and water**

## Process of Dissolving:

Solvent particles surround solute particles to form a solution in a process called **solvation**.

(This dissolving process in water is called hydration.) This process often results in a **change**

in **energy** – usually observed by an increase or decrease in temperature.

Remember the phrase **Like dissolves like** – this means that *polar dissolves polar* & nonpolar dissolves nonpolar. List examples in the table.

Polar Solvent/Solute	Nonpolar Solvent/Solute
Water and salt Tea and sugar Coke and cherry flavoring	Paint thinner and paint Makeup remover and waterproof makeup Hairspray and ink

A soluble substance is able to dissolve in a solvent because attractive forces between the solvent and solute particles are strong enough to overcome the attractive forces holding the solute together.

⚡ Some solutions conduct electricity because the solute is an electrolyte. NOTE: an electrolyte is an ionic compound that dissociates (breaks apart) in water to form a solution that conducts an electric current.

Solutes that only produce a few ions in solution would be considered a weak electrolyte and a solution that contains lots of ions would be a strong electrolyte.

**Solubility** refers to the maximum amount of solute that will dissolve in a given amount of solvent at a given temperature and pressure.

Solubility Rules determine which compounds are soluble or insoluble.

- We used solubility rules when learning about precipitation reactions in unit 7
- The solubility rules are on the back of the periodic table.

### Factors that affect solubility

#### 1. Temperature

a. Solid solutes in water: if you increase temperature, the solubility generally increases

b. Gas solutes in water: if you increase temperature, the solubility decreases

2. Amount of solute: All tables and figures showing solubility MUST indicate the amount of solvent involved

3. Agitation: Stirring or agitating any solution will generally increase dissolving by bringing fresh solvent into contact with more solute

4. Surface Area (particle size of solute): since dissolving occurs at the surface of a solid, by increasing the surface area we can increase the rate of dissolving. NOTE! Smaller particles increase surface area!!

## Types of Solutions

1. When a solvent has dissolved all the solute it can at a particular temperature, the solution is said to be saturated.

2. Unsaturated solutions have dissolved some solute but can dissolve more.

3. When a solution is heated and saturated, then if it is allowed to cool gently, it can become supersaturated. Supersaturated solutions contain more solute

than normal for that temperature, are unstable. If disturbed the excess solute will form crystals.

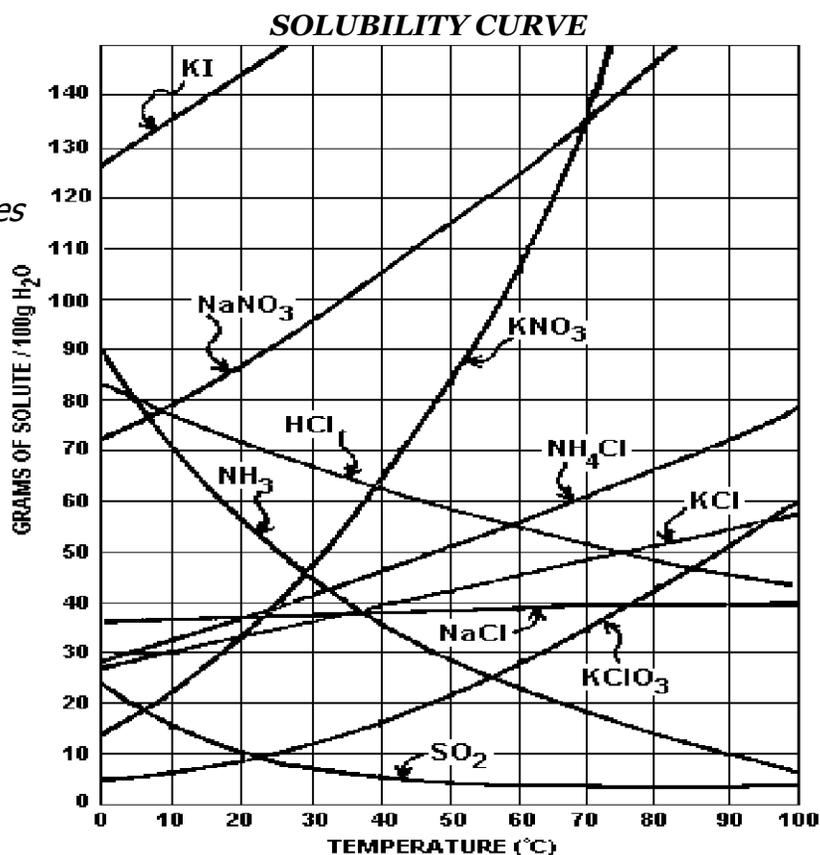
## Solubility Curves

As we begin to think about amounts of solute which will dissolve in a given amount of solvent at a particular temperature, it is usually easier to read these solubility values off of a graph.

The Solubility Curve is a graph showing the solubility of several different compounds at temperatures varying from 0°C to 100°C. Notice that MOST substances become more soluble as the temperature goes up, but not necessarily linearly and not necessarily the same increase in solubility with increase in temperature. The solubility is expressed as grams of solute dissolved in **100 grams of water**.

### Things to Remember:

- If a point is on the line, it is **saturated**
- If a point is below the line, the solution is **unsaturated**
- If a point is above the line, the solution is **supersaturated**



How many grams of potassium nitrate will saturate 100 g of water at 10° C?

How many grams of potassium nitrate will saturate 200 g of water at 10° C?

How many grams of potassium nitrate will be in the bottom of the beaker if you put 40 grams of potassium nitrate in 100 g of water at 10° C?

## Solubility of Gases

Gases are usually more soluble at **lower** temperatures and under **pressure**. (opposite of solids)

## Solution Concentration

The concentration of a solution is a **measure** of how much **solute** is dissolved in a specific amount of solvent or solutions. Concentration can be described **qualitatively** using the words **concentrated** or **dilute**.

- A **concentrated** solution contains a **large** amount of solute
- A **dilute** solution contains a **small** amount of solute

We also can express concentration **quantitatively**. We can do this by using **molarity**.

- **Molarity (M)** is one of the most common **units** used to describe the concentration of a solution. The unit (M) is read as **molar**. The larger the number, the more concentrated the solution.

To calculate the molarity of a solution, you must know the **volume** of the solution and the amount (in moles) of dissolved **solute**. See the equation below.

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

Sample Problem: Calculate the molarity of 1.60 L of a solution containing 1.55 g of dissolved KBr. Remember to convert grams to moles!

## Calculating Dilution of Solutions

Sometimes we have to **dilute** solutions to make them the right **concentration**. The equation is:  
 **$M_1V_1 = M_2V_2$**

Example Problem: When we do labs, we often use a diluted solution of hydrochloric acid. We buy concentrated HCl; it is 12M! How much 12M HCl do I need to make a 0.5 L of 0.1M solution?