

## SOLUTIONS & SOLUBILITIES

### Solutions

A **solution** is a homogeneous mixture consisting of particles 0.1–2.0 nm in diameter. Homogeneous mixtures having larger particles (2–500 nm) are classified as **colloids**. *Suspensions* are mixtures with even larger particles, but they are not considered true solutions because they separate upon standing.

We usually think of solutions as solids dissolved in liquids, or perhaps a mixture of two liquids, but there are many other kinds of solutions as well. Some examples are provided in Table 11.1.

**TABLE 11.1** Some Different Kinds of Solutions

Kind of Solution	Example
Gas in gas	Air (O <sub>2</sub> , N <sub>2</sub> , Ar, and other gases)
Gas in liquid	Carbonated water (CO <sub>2</sub> in water)
Gas in solid	H <sub>2</sub> in palladium metal
Liquid in liquid	Gasoline (mixture of hydrocarbons)
Liquid in solid	Dental amalgam (mercury in silver)
Solid in liquid	Seawater (NaCl and other salts in water)
Solid in solid	Metal alloys, such as sterling silver (92.5% Ag, 7.5% Cu)

For solutions in which a gas or solid is dissolved in a liquid, the dissolved substance is called the **solute** and the liquid is called the **solvent**. When one liquid is dissolved in another, the minor component is usually considered the solute.

**Solution:** a homogeneous mixture containing particles the size of a typical ion or covalent molecule

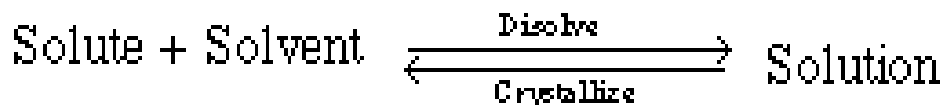
**Colloid:** a homogeneous mixture containing particles with diameters in the range 2–500 nm

**Solute:** the dissolved substance in a solution

**Solvent:** the major component in a solution

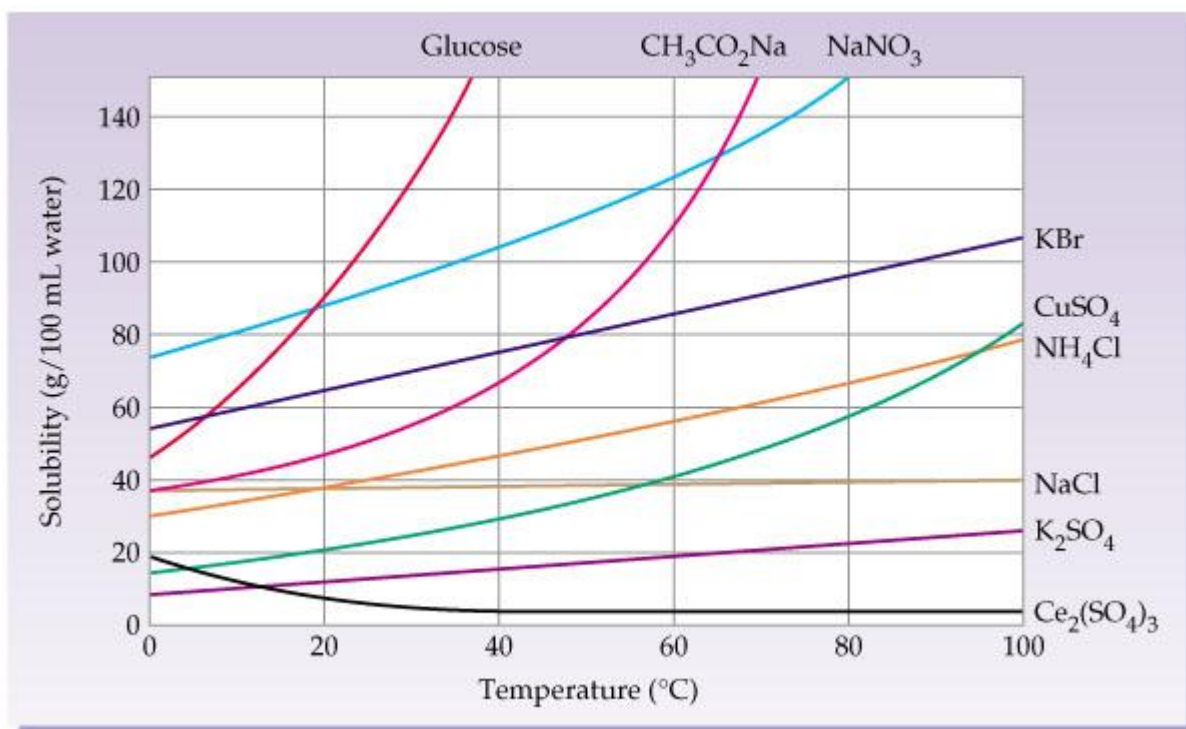
## Factors Affecting Solubility

A solution is **saturated** when no additional solute can be dissolved. There is a dynamic equilibrium established.



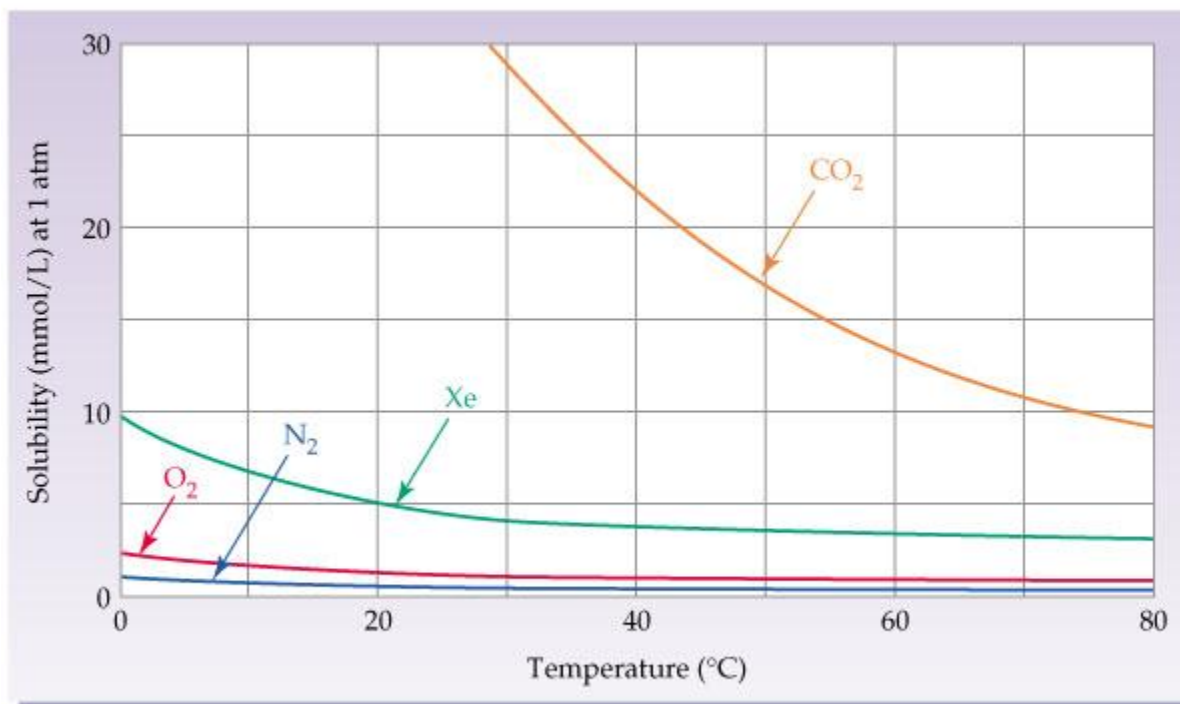
A **supersaturated** solution can form when more than the equilibrium amount of solute is dissolved at an elevated temperature, and then the supersaturated solution is slowly cooled.

The amount of solute per unit solvent required to form a saturated solution is called the solute's **solubility**. A substance's solubility is a characteristic of that substance. Figure 11.5 illustrates the solubilities of some solids, and their temperature dependence.



When two liquids are completely soluble in each other they are said to be **miscible**.

The effect of temperature on gas solubility is more predictable than solid solubility. Most gases become less soluble in water as the temperature increases.



Pressure has little effect on the solubility of liquids and solids. The solubility of gases is strongly influenced by pressure

**Saturated solution:** a solution containing the maximum possible amount of dissolved solute at equilibrium

**Supersaturated solution:** a solution containing a greater-than-equilibrium amount of solute

**Solubility:** the amount of a substance that dissolves in a given volume of solvent

**Miscible:** mutually soluble in all proportions

**Henry's law:** The solubility of a gas in a liquid at a given temperature is directly proportional to the partial pressure of the gas over the solution

**TABLE 4.1 Solubility Guidelines for Common Ionic Compounds in Water**

<b>Soluble Compounds</b>	<b>Important Exceptions</b>
Compounds containing $\text{NO}_3^-$	None
$\text{C}_2\text{H}_3\text{O}_2^-$	None
$\text{Cl}^-$	Compounds of $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , and $\text{Pb}^{2+}$
$\text{Br}^-$	Compounds of $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , and $\text{Pb}^{2+}$
$\text{I}^-$	Compounds of $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , and $\text{Pb}^{2+}$
$\text{SO}_4^{2-}$	Compounds of $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Hg}_2^{2+}$ , and $\text{Pb}^{2+}$
<b>Insoluble Compounds</b>	<b>Important Exceptions</b>
Compounds containing $\text{S}^{2-}$	Compounds of $\text{NH}_4^+$ , the alkali metal cations, and $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , and $\text{Ba}^{2+}$
$\text{CO}_3^{2-}$	Compounds of $\text{NH}_4^+$ and the alkali metal cations
$\text{PO}_4^{3-}$	Compounds of $\text{NH}_4^+$ and the alkali metal cations
$\text{OH}^-$	Compounds of the alkali metal cations, and $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , and $\text{Ba}^{2+}$

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