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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_2, N_2, Ar, and other gases)
Gas in liquid	Carbonated water (CO_2 in water)
Gas in solid	H_2 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

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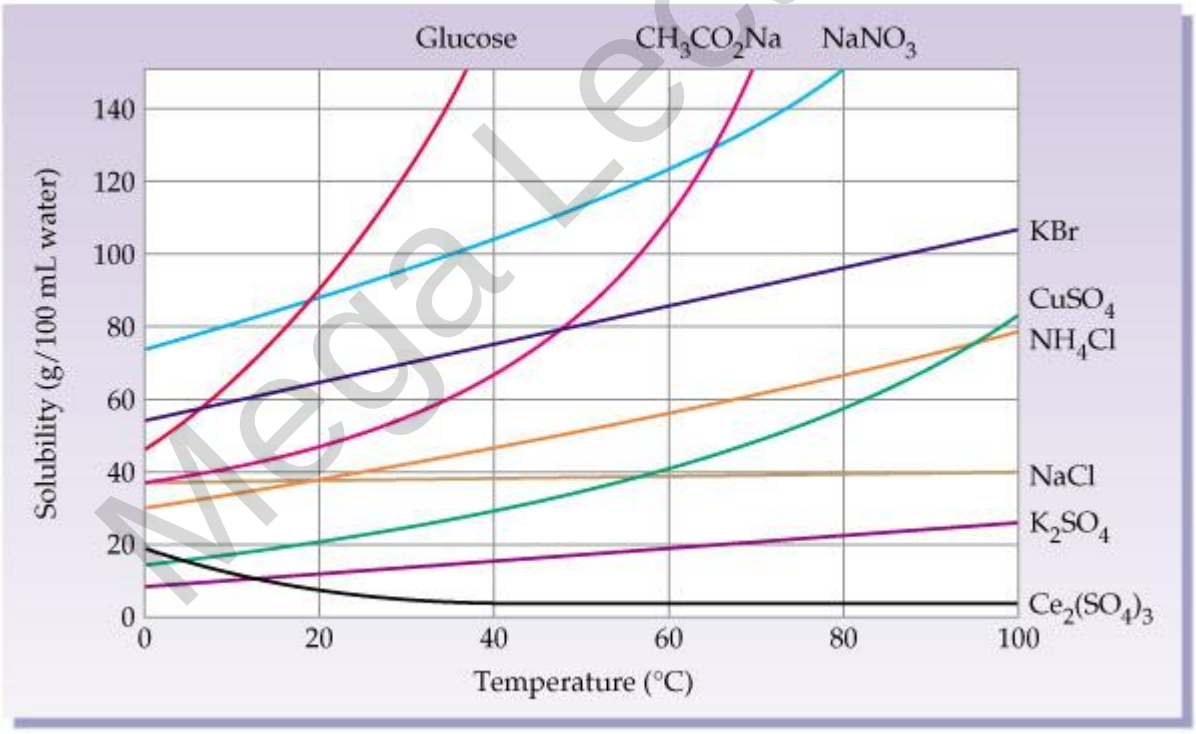
Factors Affecting Solubility

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

$$\text{Solute} + \text{Solvent} \underset{\text{Crystallize}}{\overset{\text{Dissolve}}{\rightleftharpoons}} \text{Solution}$$

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.

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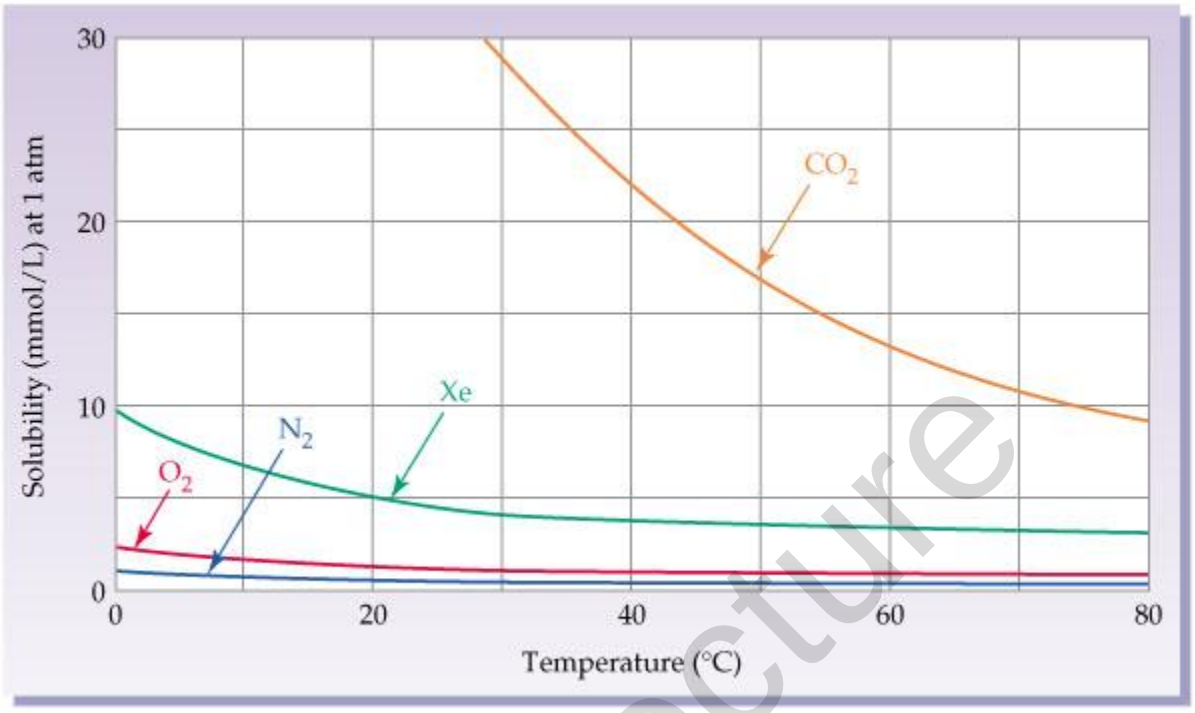

Pressure has little effect on the solubility of liquids and solids. The solubility of gases is strongly influenced by pressure

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

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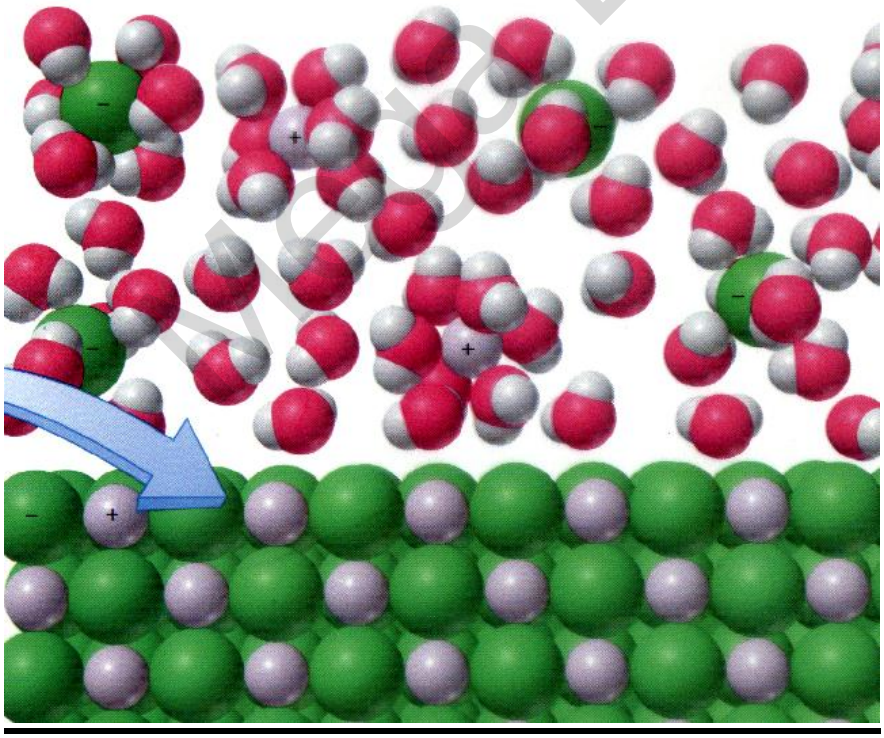
TABLE 4.1 Solubility Guidelines for Common Ionic Compounds in Water

Soluble Compounds		Important Exceptions
Compounds containing	NO_3^-	None
	$C_2H_3O_2^-$	None
	Cl^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	Br^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	I^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	SO_4^{2-}	Compounds of Sr^{2+}, Ba^{2+}, Hg_2^{2+}, and Pb^{2+}
Insoluble Compounds		**Important Exceptions**
Compounds containing	S^{2-}	Compounds of NH_4^+, the alkali metal cations, and Ca^{2+}, Sr^{2+}, and Ba^{2+}
	CO_3^{2-}	Compounds of NH_4^+ and the alkali metal cations
	PO_4^{3-}	Compounds of NH_4^+ and the alkali metal cations
	OH^-	Compounds of the alkali metal cations, and Ca^{2+}, Sr^{2+}, and Ba^{2+}

Page 482 NaCl Dissolving



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