Properties of Dilute Solution

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The contents of this presentation is made to provide a brief idea about the topic, details will be discussed in the classes. Contents have been collected from multiple textbooks and internet.

What is Solution?

A ***solution*** is a homogenous mixture of 2 or more substances

The ***solute*** is(are) the substance(s) present in the smaller amount(s)

The ***solvent*** is the substance present in the larger amount

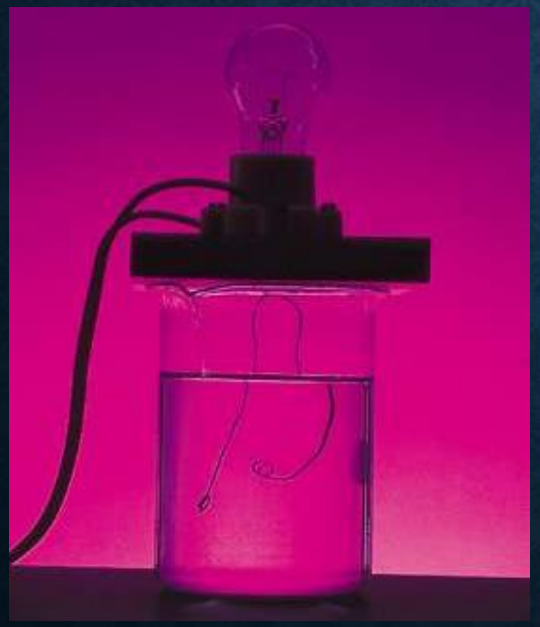
Types of Solutions

Types of Solutions

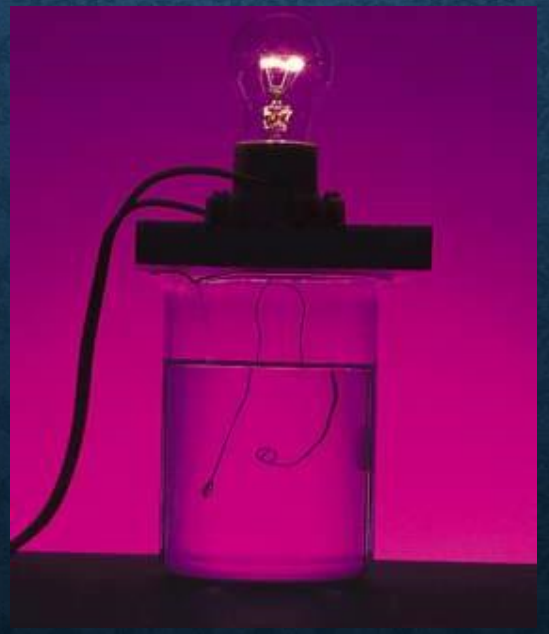
Component 1	Component 2	State of Resulting Solution	Examples
Gas	Gas	Gas	Air
Gas	Liquid	Liquid	Soda water (CO_2 in water)
Gas	Solid	Solid	H_2 gas in palladium
Liquid	Liquid	Liquid	Ethanol in water
Solid	Liquid	Liquid	NaCl in water
Solid	Solid	Solid	Brass (Cu/Zn), solder (Sn/Pb)

Types of Solutions

- An *electrolyte* is a substance that, when dissolved in water, results in a solution that can conduct electricity.
- A *nonelectrolyte* is a substance that, when dissolved, results in a solution that does not conduct electricity.



nonelectrolyte



weak electrolyte

strong electrolyte

Types of Solutions

A *saturated solution* contains the maximum amount of a solute that will dissolve in a given solvent at a specific temperature.

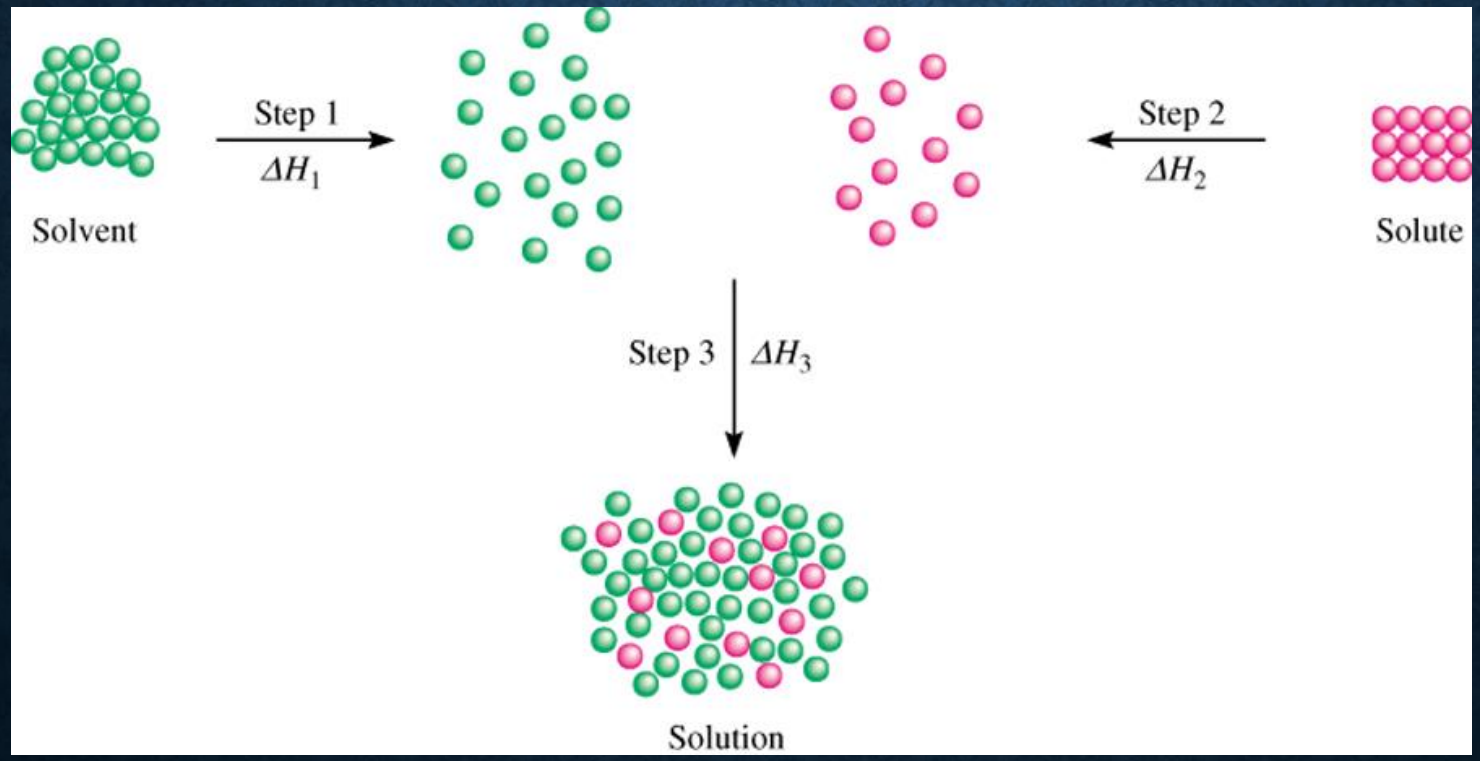
An *unsaturated solution* contains less solute than the solvent has the capacity to dissolve at a specific temperature.

A *supersaturated solution* contains more solute than is present in a saturated solution at a specific temperature.

Sodium acetate crystals rapidly form when a seed crystal is added to a supersaturated solution of sodium acetate.

Three types of interactions in the solution process:

- solvent-solvent interaction
- solute-solute interaction
- solvent-solute interaction



$$\Delta H_{soln} = \Delta H_1 + \Delta H_2 + \Delta H_3$$

Factors Affecting Solubility

Temperature

- For solid solutes: as temperature increases, solubility increases.
- For gas solutes: as temperature increases, solubility decreases.

Pressure

- For solid solutes: as pressure increases, solubility remains the same.
- For gas solutes: as pressure increases, solubility increases

Factors Affecting Solubility

Nature of Solute/Solvent

“Like dissolves in like.”

Solute Type	Nonpolar solvent	Polar Solvent
Nonpolar (Fat Grease)	Soluble (soap)	Insoluble (water)
Polar	Insoluble	Soluble (water)
Ionic (salt)	insoluble	Soluble (water)

The effect of pressure on gas solubility

Henry's Law

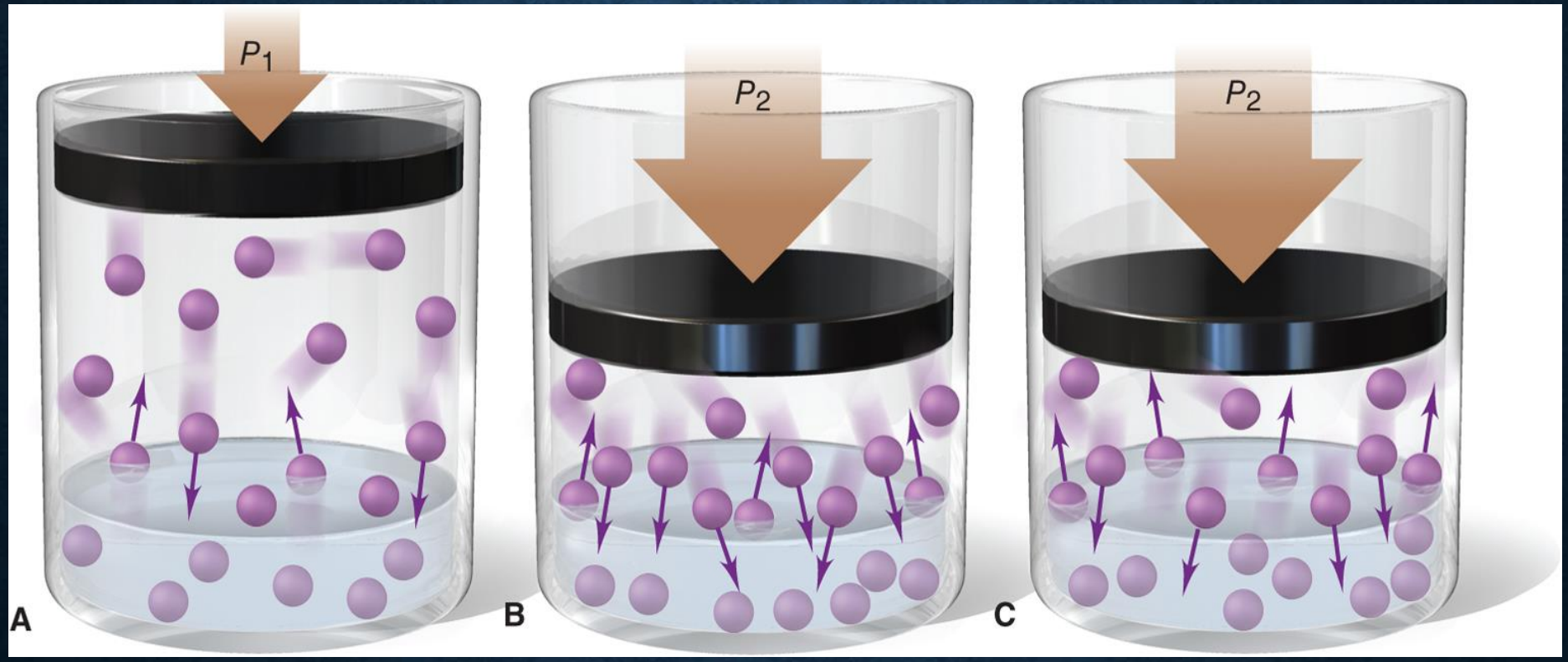
The solubility of a gas in a solvent depends on the pressure and the temperature. When a gas is enclosed over its saturated solution, the following equilibrium exists.

$$\text{gas} \leftrightarrow \text{gas in solution}$$

For a gas in contact with a solvent at constant temperature, concentration of the gas that dissolves in the solvent is directly proportional to the pressure of the gas.

$$C \alpha P$$

The effect of pressure on gas solubility



As the pressure is increased, more gas particles collide with the liquid surface. More gas particles dissolve until equilibrium is re-established.

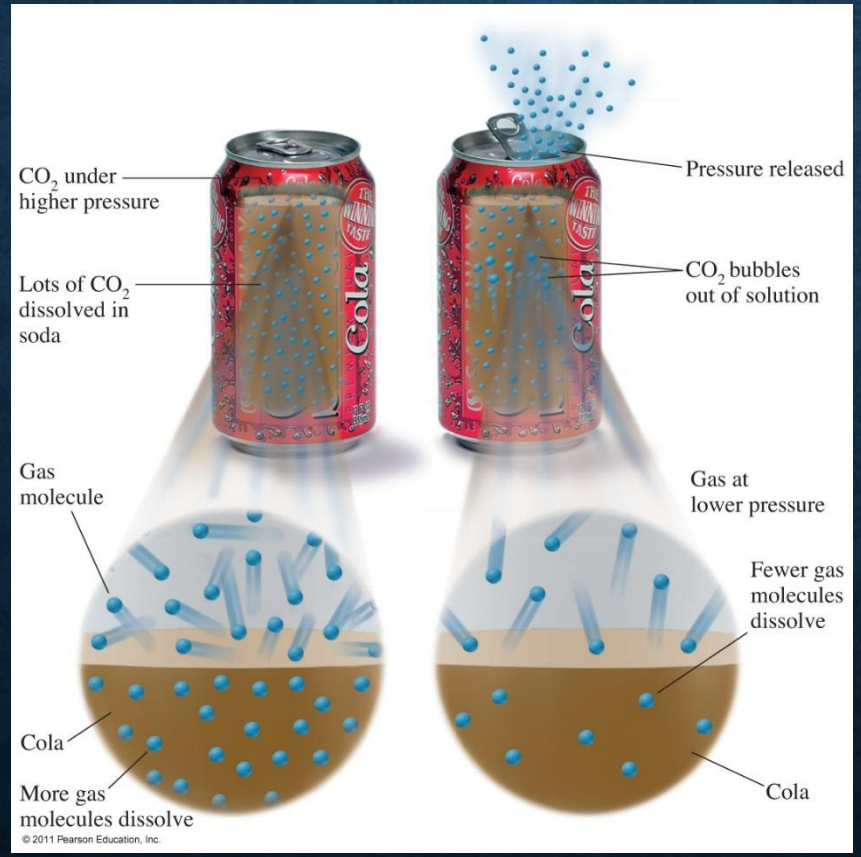
The effect of pressure on gas solubility

- An example of Henry's law is demonstrated when a can of soda is opened at room temperature and poured into a glass. The dissolved carbon dioxide will fizz and escape from the liquid.

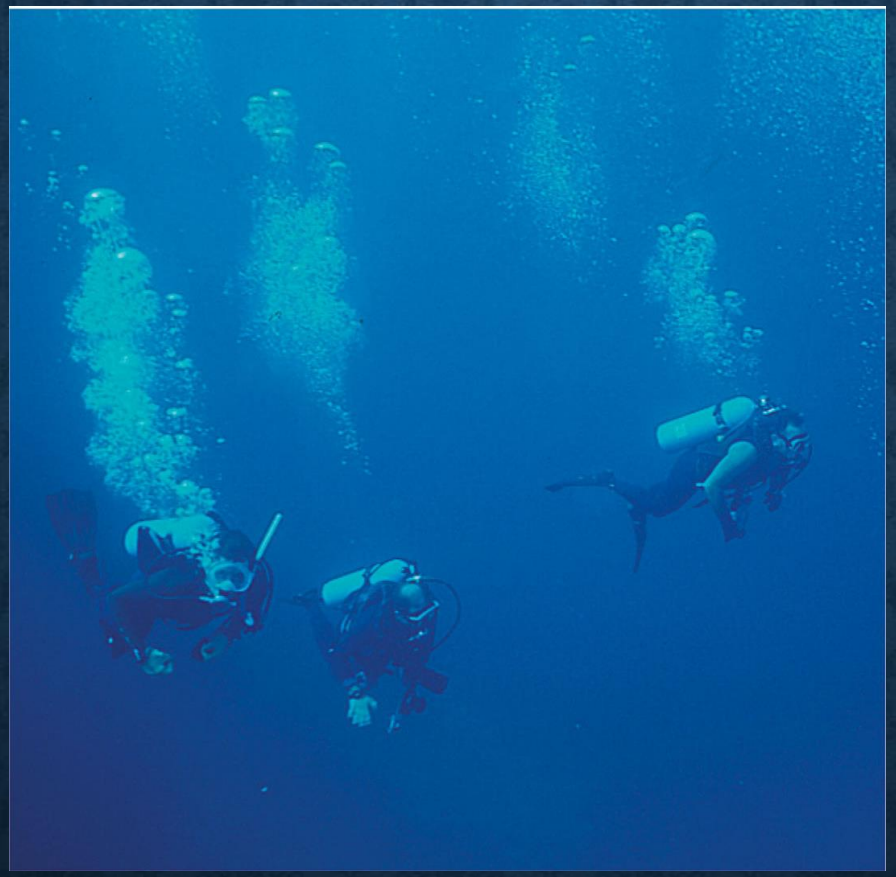
- The hissing sound made when a soda is opened is a result of the space above the beverage in the container, which is filled with carbon dioxide at a higher pressure than the surrounding atmosphere. The gas then escapes quickly once the seal is broken.

The effect of pressure on gas solubility

The amount of carbon dioxide that was dissolved in the drink at a higher pressure will not stay dissolved once the drink is opened at a lower pressure.



The effect of pressure on gas solubility



Implications for scuba diving

Concentration Units of Solution

The *concentration* of a solution is the amount of solute present in a given quantity of solvent or solution.

Molarity *(M)*

$$M = \frac{\text{moles of solute}}{\text{liters of solution}}$$

Molality *(m)*

$$m = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}}$$

Normality *(N)*

$$N = \frac{\text{gram equivalent of solute}}{\text{liters of solution}}$$

Concentration Units of Solution

Percent by Mass

$$\% \text{ by mass} = \frac{\text{mass of solute}}{\text{mass of solute} + \text{mass of solvent}} \times 100\%$$

$$= \frac{\text{mass of solute}}{\text{mass of solution}} \times 100\%$$

Mole Fraction *(X)*

$$X_A = \frac{\text{moles of A}}{\text{sum of moles of all components}}$$