Section 11.1
The Dissolution Process

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Learning Objectives

- Describe the basic properties of solutions and how they form
- Predict whether a given mixture will yield a solution based on molecular properties of its components
- Explain why some solutions either produce or absorb heat when they form

Solution Vocabulary

- **Solutions** are homogeneous mixtures of two or more substances.
- The **Solvent** is the component of the solution with significantly higher concentration.
- **Solutes** are components of the solution present in relatively smaller concentrations.
- When a solution forms solute is distributed evenly throughout the solvent.

Solution Phases

- Components of a solution can be any phase.
- **Aqueous** solutions (aq) have a water solvent.
- **Alloys** are solid solutions of two metals.
- Air is solution of gases with a nitrogen solvent.

Solution	Solute	Solvent
air	$O_2(g)$	$N_2(g)$
soft drinks[1]	$CO_2(g)$	$H_2O(l)$
hydrogen in palladium	$H_2(g)$	$Pd(s)$
rubbing alcohol	$H_2O(l)$	$C_3H_8O(l)$ (2-propanol)
saltwater	$NaCl(s)$	$H_2O(l)$
brass	$Zn(s)$	$Cu(s)$

Solution Properties

- They are homogeneous
  - After a solution is mixed, its composition is uniform.
- The physical state of a solution is typically the same as that of the solvent.
- The components of a solution are dispersed on a molecular scale
- They consist of a mixture of separated solute particles
  - Molecules, atoms, and/or ions are each closely surrounded by solvent species.

Solution Properties

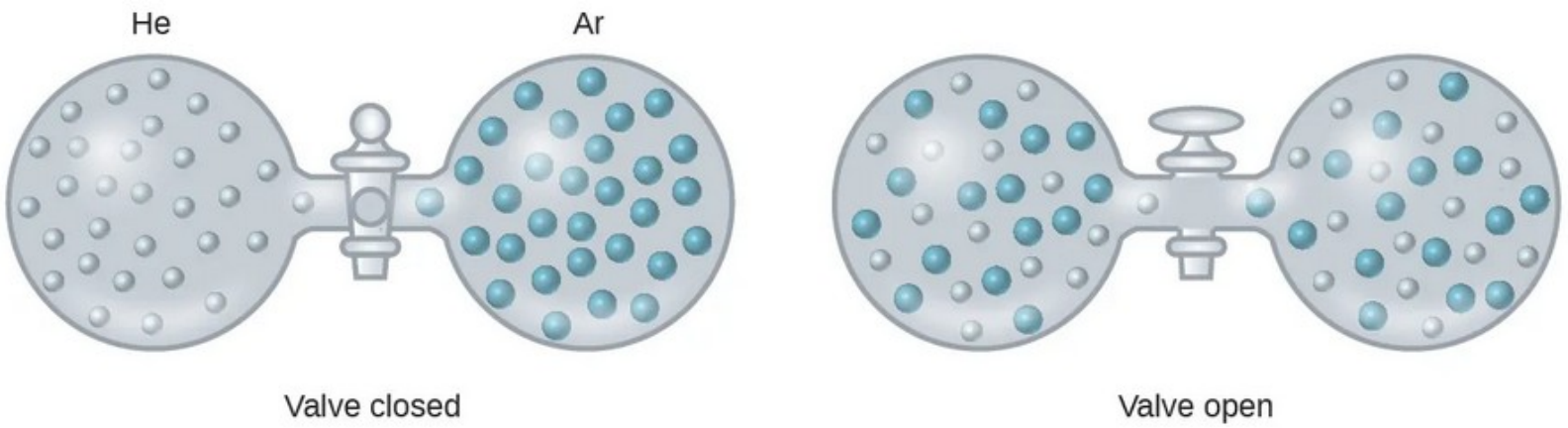
- The dissolved solute in a solution will not settle out or separate from the solvent.
- The composition of a solution, or the concentrations of its components, can be varied continuously.
  - Within limits determined by the solubility

Spontaneity

- The formation of a solution is **spontaneous process**
  - Occurs under specified conditions without requiring the input of external energy.
  - Decrease the internal energy of the system, exothermic, $\Delta H < 0$.
  - Increases the dispersal of matter in the system, $\Delta S > 0$.
- Heating and stirring may *speed up* the dissolution process. But they are not *necessary*.
  - Stirring will only speed up dissolution, it will not increase or decrease the amount of solute dissolved.
  - Heating can speed or slow the dissolution process, it also effects the amount of solute dissolved.

Ideal Solutions

- **Ideal Solutions** occur when the strengths of the intermolecular forces of attraction between solute and solvent species are the same the IMFs present in the separated components
  - The solution is formed with no accompanying energy change, $\Delta H = 0$.



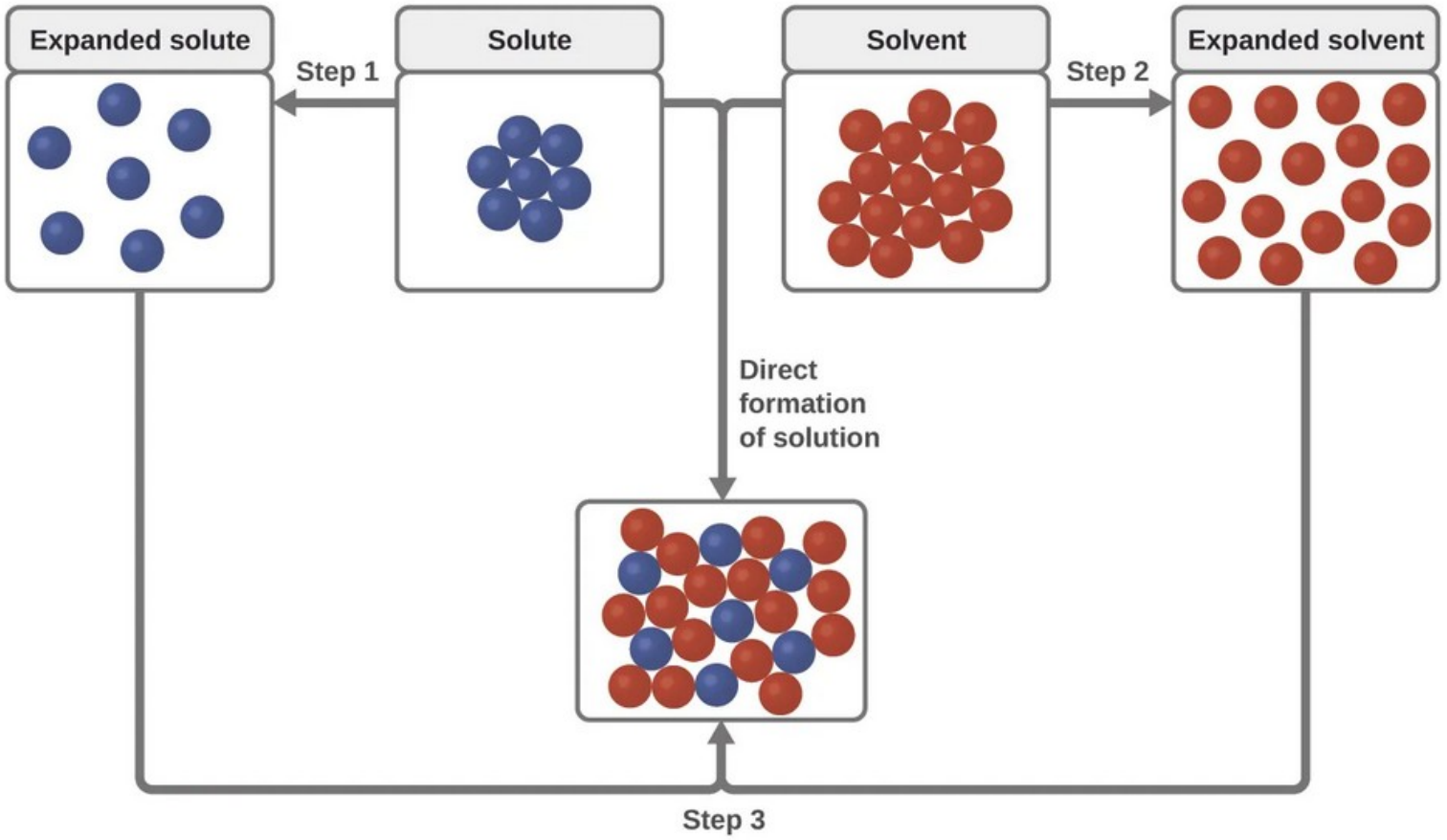
Ideal Solutions

- Ideal solutions may also form when structurally similar liquids are mixed.
- Some ideal solutions do experience intermolecular attractive forces. But since the molecules of the two substances being mixed are structurally very similar, the intermolecular attractive forces between like and unlike molecules are essentially the same.

Solvation

- When a solution is formed, three steps occur
  - Solute-solute attractions are overcome (endothermic)
  - Solvent-solvent attractions are overcome (endothermic)
  - Solvent-solute attractions are formed (exothermic)
- The process of forming solvent-solute attractions is called **solvation**.
- Solutions form when the energy released during solvation is greater than the energy required to overcome solute-solute and solvent-solvent interactions.

Solvation


Expanded solute
Step 1
Solute
Solvent
Step 2
Expanded solvent
Direct
formation
of solution
Step 3

Endothermic Dissolution

- Most spontaneous solvation reactions are exothermic.
- It is possible to have an endothermic solvation reaction.
- These reactions are driven entirely by the increase in disorder caused by dissolution.