The Nature of Solutions

Solubility

© Evan P. Silberstein, 2008
The Definition of Solutions

• Definition: Solution = homogeneous mixture

• Nature of mixtures
  o Consists of two or more kinds of matter
  o Each substance in a mixture retains its own properties
    • sugar and water - sweet and wet
    • brine (salt water) - salty liquid
  o The composition is variable (not constant)
  o Can be separated by physical means
Solutions vs. Mechanical Mixtures

<table>
<thead>
<tr>
<th>Solution</th>
<th>Mechanical Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homogeneous</td>
<td>Heterogeneous</td>
</tr>
</tbody>
</table>

- Solutions are composed of two or more substances *BUT* the particles are distributed evenly throughout each other *SO* the composition is uniform.
  - The solution appears to be one substance even though it is two or more.
A solution consists of a **solute** dissolved in a **solvent**.

- **Solute** - substance that *is* dissolved by another
- **Solvent**
  - substance that dissolves another
  - continuous phase

**Example:**
Salt dissolved in water appears to be a liquid.
The water is the continuous phase.
The water is the solvent.
The ability to dissolve in water

SOLUBILITY
Factors Affecting Solubility

• Degree of solubility (how much dissolves)
• Temperature
• Pressure
Degree of Solubility

• Nature of solute and solvent
  o In order for a solvent to dissolve a solute, it must exert forces of attraction on the solute.
  o Polar solvents such as water dissolve polar and ionic solutes because they exert mutual attractions that cause their particles to intermingle.
  o Nonpolar solvents such as benzene do NOT dissolve polar and ionic substances because they exert no forces of attraction that would cause the particles to separate so they can intermingle.
  • Oil and water do NOT mix.
  o Nonpolar substances such as fat dissolve in nonpolar solvents such as benzene because the forces of attraction are too weak to prevent the particles from freely intermingling.

• **Like** dissolves **like**.
The Reference Tables provide solubility guidelines.

Which of the following is soluble in water?

- \((\text{NH}_4)_3\text{PO}_4\) ✓
- Ag\(_2\)S ✗
- Na\(_2\)CO\(_3\) ✓
Considerations

• What happens to the particles of a solid when they dissolve in water? They separate.

• What happens to the particles of a gas when they dissolve in water? They come together.

Effect of Temperature

• Solubility of solid solutes generally increases as temperature increases.

• Solubility of gaseous solutes generally decreases as temperature increases.
Considerations

• When solids dissolve in water the particles separate. What effect does pressure have on the distance between the particles of a solid?
  None.

• When gases dissolve in water the particles come together. What effect does pressure have on the distance between the particles of a gas?
  Pressure pushes them together.

Effect of Pressure

• Solubility of solid solutes is not affected by pressure.

• Solubility of gaseous solutes increases as pressure increases.
  o Henry’s Law – the mass of a dissolved gas in a liquid is directly proportional to the pressure of the gas.
# Rate of Solution

<table>
<thead>
<tr>
<th>Factor</th>
<th>Affect on Solid Solute</th>
<th>Affect on Gaseous Solute</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Particle Size</strong></td>
<td>Reducing particle size by crushing increases the rate by increasing surface area.</td>
<td>Not applicable</td>
</tr>
<tr>
<td><strong>Stirring</strong></td>
<td>Increases the rate by exposing fresh solvent to solute and increasing kinetic energy.</td>
<td>Decreases the rate by increasing kinetic energy, thereby reducing solubility.</td>
</tr>
<tr>
<td><strong>Amount of dissolved solute</strong></td>
<td>As the amount of dissolved solute increases, the rate decreases.</td>
<td>As the amount of dissolved solute increases, the rate decreases.</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>As the temperature increases, the rate increases.</td>
<td>As the temperature increases, the rate decreases.</td>
</tr>
</tbody>
</table>