Chapter 4: Types of Chemical Reactions

- 4.1 Water
- 4.2 Electrolytes
- 4.3 Composition of Solutions

Exam #1 - Next Friday (Sep 14)

Characteristics of Water

- Composition: H₂O
- Bent shape
- Covalent -OH bonds
- Polar (unequal charge distribution)
**Why is Water Bent?**

Oxygen has 2 lone pairs of electrons.

To avoid steric hindrance, the -OH bonds spread to a 105° angle.

*More on shapes of molecules later...*

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**Dissolution**

Polar water molecules aid in dissolving ions of a salt.

*Text Fig. 4.2*
When a solid or liquid enters into an aqueous phase

\[ \text{NH}_4\text{NO}_3(s) + \text{H}_2\text{O}(l) \rightarrow \text{NH}_4^+(aq) + \text{NO}_3^-(aq) \]

What is Dissolution?

-Ammonium (solid)\[\rightarrow\]Ammonium (in solution)
-Nitrate (solid)\[\rightarrow\]Nitrate (in solution)

Like Dissolves Like

Ethanol

Water interacting with ethanol

Substances with similar intermolecular attractive forces tend to be soluble in one another.
Polar Water & Dissolution

Water will not dissolve nonpolar substances.

**NONPOLAR**
Hydrocarbons
- Fats
- Oils
- Grease
- Gasoline
- Dry Cleaning Solvents
  etc.

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Polar Water & Dissolution

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Hydrocarbons
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苯 

\[ \text{CH}_3 \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CH}_3 \]

n-Octane \( \text{C}_8\text{H}_{18} \)
Solubility

The largest amount of a substance that can dissolve in a specific amount of solvent at RT

- **Soluble**
  - > 1 gram of solute per 100 g water

- **Slightly Soluble**
  - 0.01 - 1 gram of solute per 100 g water

- **Insoluble**
  - < 0.01 gram of solute per 100 g water

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Solubility Concepts

1. Pairs of liquids that mix in any proportion are termed **miscible**.

2. Liquids that do not mix are termed **immiscible**.

3. Substances with similar intermolecular attractive forces tend to be soluble in one another.
Electrolytes

Substances that dissolve in H\(_2\)O to give solutions that conduct electricity better than H\(_2\)O alone does.

<table>
<thead>
<tr>
<th></th>
<th>Strong</th>
<th>Weak</th>
<th>Non-Electrolyte</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrolytes</td>
<td>Hydrochloric Acid</td>
<td>Acetic Acid</td>
<td>Sucrose</td>
</tr>
</tbody>
</table>

K\(_2\)SO\(_4\) \[\begin{array}{c} \text{Ionization} \\ \rightarrow \end{array}\] 2K\(^+\) + SO\(_4^{2-}\)
Strong Electrolytes

- **Soluble Salts**
  - Dissolve completely into cations and anions
  - Examples: NaCl, KCl, and NH₄Cl

- **Strong Acids**
  - Dissolve in water to make H⁺
  - Examples: HCl, HNO₃, and H₂SO₄

- **Strong Bases**
  - Dissolve in water to make OH⁻
  - NaOH and KOH

Weak Electrolytes

- **Produce few ions when dissolved in water**
- **Weak Acid**: Acetic Acid
- **Weak Base**: Ammonia
Weak Electrolytes

PRS Question
What ion(s) will be formed from dissolution of acetic acid, HC₂H₃O₂, in water?

1. OH⁻
2. H⁺
3. H³⁺
4. H⁺ and OH⁻

PRS Q1 Answer
What ion(s) will be formed from dissolution of acetic acid, HC₂H₃O₂, in water?

\[
\text{HC}_2\text{H}_3\text{O}_2 \rightarrow \text{H}^+ + \text{C}_2\text{H}_3\text{O}_2^-
\]

Acetic Acid
Acetate Anion

1. OH⁻
2. H⁺
3. H³⁺
4. H⁺ and OH⁻

Correct Answer
You know H⁺ will form since the solute here is an acid.
Weak Electrolytes

- Produce few ions when dissolved in water
- Weak Acid: Acetic Acid
- Weak Base: Ammonia

**PRS Question**

What ion(s) will be formed from dissolution of ammonia, NH₃, in water?

1. OH⁻
2. NH⁴⁺
3. 1 and 2
4. None of these
What ion(s) will be formed from dissolution of ammonia, NH₃, in water?

1. OH⁻
2. NH⁴⁺
3. 1 and 2
4. None of these

NH₃ + H₂O → NH⁴⁺ + OH⁻

Note: Choice #2 was a typo! It was supposed to be NH₄⁺. Then Choice #3 would be the correct answer as stated in the lecture period.

Molarity & Dilutions

\[
\text{concentration}_{\text{solute}} = \frac{\text{amount}_{\text{solute}}}{\text{Volume}_{\text{solution}}}
\]

\[M = \text{molarity} = \frac{\text{moles}_{\text{solute}}}{\text{liters}_{\text{solution}}}
\]

\[M_1 \times V_1 = M_2 \times V_2\]
### Calculations

Molarity calculation:

\[
M = \text{molarity} = \text{mol L}^{-1} \quad M_1 \times V_1 = M_2 \times V_2
\]

**What volume of blood contains 1.0 mg of NaCl if typical blood serum is 0.14 M NaCl?**

FW of NaCl = 58.45 g/mol

See Example 4.3 in the text

### Next Friday

- **Types of Chemical Reactions**
  - Precipitation Reactions
  - Acid-Base Reactions
  - Oxidation-Reduction ("Redox") Reactions

- **Reminder:** Exam #1 - Friday, Sep 14
  
  Attendance is mandatory!