Chapter 4. Reactions in Aqueous Media

Solubility and Precipitation

<table>
<thead>
<tr>
<th>Soluble</th>
<th>Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>group IA cations, NH₄⁺</td>
<td>most other cations</td>
</tr>
<tr>
<td>NO₃⁻, CH₃COO⁻, ClO₃⁻</td>
<td>OH⁻, CO₃²⁻, PO₄³⁻, S²⁻</td>
</tr>
<tr>
<td>Cl⁻, Br⁻, I⁻ (except with Ag⁺, Pb²⁺, Hg₂²⁺)</td>
<td></td>
</tr>
<tr>
<td>SO₄²⁻ (except with Ca²⁺, Sr²⁺, Ba²⁺, Pb²⁺, Hg₂²⁺)</td>
<td></td>
</tr>
</tbody>
</table>

A precipitation reaction involves the production of an insoluble compound:

Precipitation: soluble reactants yield an insoluble solid product that drops out of solution.

Acid-base reactions: acid reacts with base to form a salt plus water.

Oxidation-reduction: electrons transferred between reactants.

Electrolytes vs. Nonelectrolytes

- Electrolytes: Substances that dissolve in water to produce ionic solutions.
  - Strong electrolytes dissociate completely to form many ions in solution.
  - Weak electrolytes produce fewer ions because only a small amount of the compound dissociates.
- Nonelectrolytes: Substances that do not form ions when they dissolve in water.
- Dissociation: The process by which a compound splits up to form ions in the solution.

\[ \text{NH}_3\text{OH(s)} \xrightarrow{\text{H}_2\text{O}} \text{NH}_4^+(aq) + \text{OH}^-(aq) \]

Acids and Bases

Acid: a source of hydrogen ions (H⁺) in aqueous solution (more properly H₂O⁺).

- Hydrochloric acid: HCl(aq) + H₂O(l) → H₃O⁺(aq) + Cl⁻(aq)
  - Strong electrolyte → strong acid
- Acetic acid: CH₃COOH(aq) + H₂O(l) → H₃O⁺(aq) + CH₃COO⁻(aq)
  - Weak electrolyte → weak acid

Oxidation - Reduction (Redox) Rxns

Involves electron transfer between reactants

\[ 2\text{Ag}^+(aq) + \text{Cu(s)} \rightarrow 2\text{Ag}(s) + \text{Cu}^{2+}(aq) \]

- Ag⁺ accepts an electron from Cu and is reduced to Ag⁻ charge reduced
- Cu donates electrons to Ag⁺ and is oxidized to Cu²⁺ charge increased

Ag⁺ is oxidizing agent.

Redox rxn can be considered a combination of half reactions.

\[ 2\text{Ag}^+ + 2\text{e}^- \rightarrow 2\text{Ag} \]
\[ \text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu} \]

Driving force for Ag⁺ reduction is greater than for Cu²⁺ reduction

Easy to see the charges in this rxn. In general, "oxidation number" plays the role of charge.