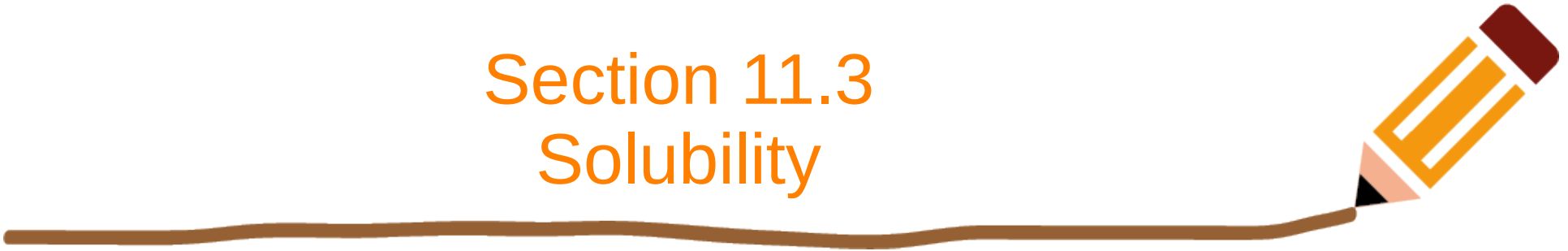
Section 11.3
Solubility



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Learning Objectives

- Describe the effects of temperature and pressure on solubility
- State Henry's law and use it in calculations involving the solubility of a gas in a liquid
- Explain the degrees of solubility possible for liquid-liquid solutions

Solubility

- **Solubility** of a solute in a particular solvent is the maximum concentration that may be achieved, under given conditions, when the dissolution process is at *equilibrium*.
- A solution whose solute concentration is equal to its solubility is **saturated**.
- If the solute concentration is less than its solubility, the solution is **unsaturated**.
- Solutions with relatively low solute concentration is **dilute**.
- Solutions with relatively high solute concentration is **concentrated**.

Supersaturated

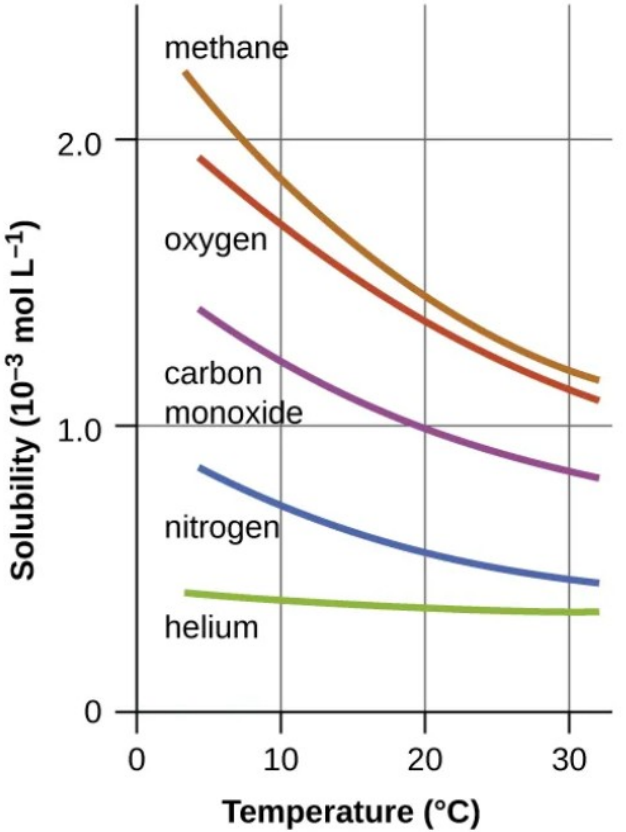
- Solutions with solute concentration exceeding its solubility is called **supersaturated**.
  - This is a nonequilibrium condition
- Solute will leave the solution until equilibrium is reached.

Solutions of Gases in Liquids

- Gases have only very weak intermolecular forces, therefore there is little or no solute-solute interaction to overcome during solvation.
- When the solvent-solute interactions exceed solvent-solvent interactions in strength, solvation will occur.
- Consequently, gases are more soluble in solvents with weak IMFs and gases capable of forming stronger IMFs are more soluble.

Solubility of Gases and Temperature

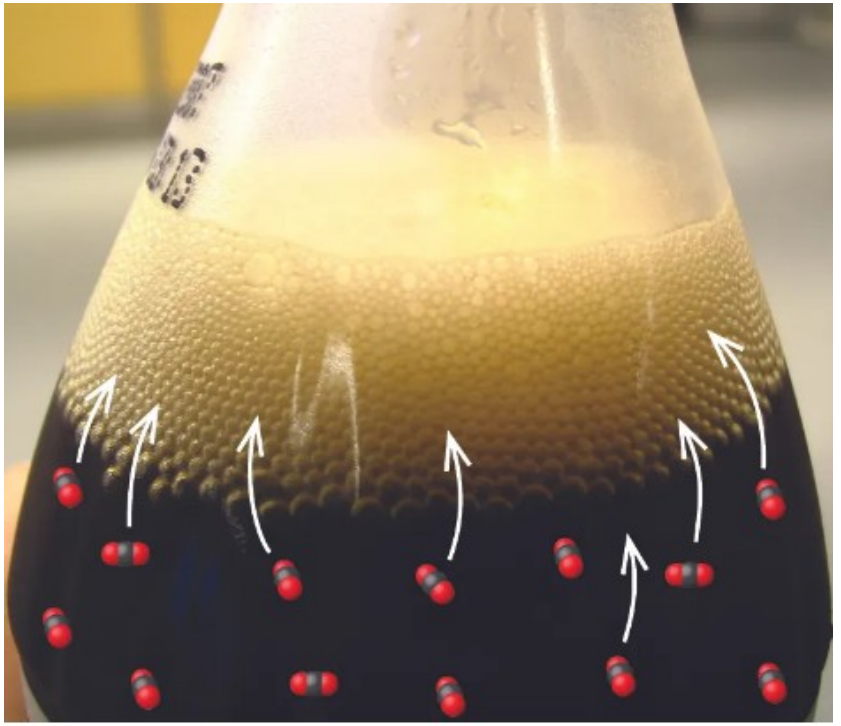
- Typically, gases are more soluble in colder liquids.
- The decreased solubility of oxygen, carbon dioxide, and other gases in water is a major consequence of climate change.



Gas Solubility and Partial Pressure

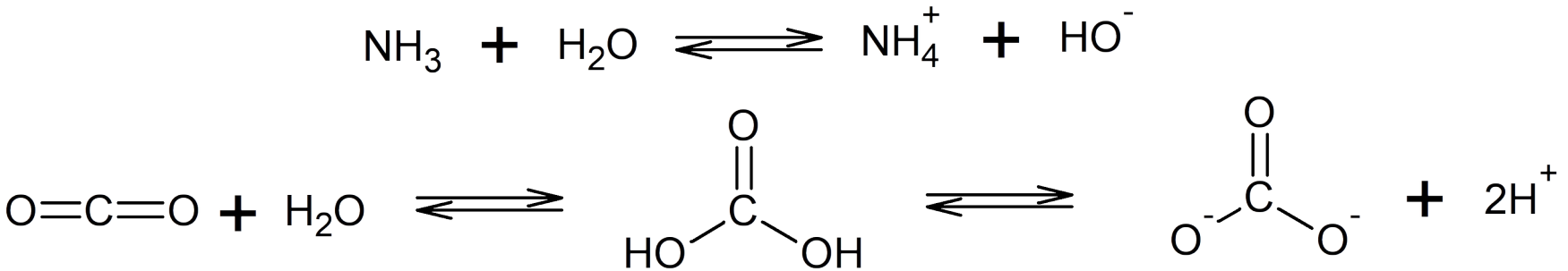
- The solubility of gases increase with the partial pressure of the gas above a liquid.
- Many gases under most conditions will follow *Henry's Law.*

$$C_g = kP_g$$



Deviations From Henry's Law

- The solubility of gases will deviate from Henry's Law when chemical reactions occur between the solute and solvent.



Solutions of Liquids in Liquids

- Sometimes solutes and solvents can be mixed in any proportions i.e. they have **infinite solubility.**
- Liquid-liquid solutions that are infinite soluble are called **miscible**.
- Miscible liquids will have very similar properties.
  - Solute-solute, solvent-solvent, and solute-solvent IMFs will have comparable strength.
- Polar solvents will dissolve polar solvents and nonpolar solvents will dissolve nonpolar solvents.
  - *Like dissolves like*

Solutions of Liquids in Liquids

- When only a moderate portion of one liquid will dissolve in another the liquids are **partially miscible**.
- When two liquids do not mix they are called **immiscible**.
- Immiscible liquids will form two layers with the less dense liquid on top.
- It is rarely, if ever, the case that two liquids have zero mutual solubility.

Solutions of Solids in Liquids

- Typically, the solubility of solids in liquids increases with temperature.
- Leveraging the temperature dependence of the solubility of solid-liquid solutions is the most common way of preparing supersaturated solutions.