Thermodynamics

First Law: $\Delta U = q + w$
Enthalpy: $H = U + pV$
Heat Capacity: $C_p = \left(\frac{\partial H}{\partial T}\right)_p$, $C_v = \left(\frac{\partial U}{\partial T}\right)_v$
Second Law: $dS \geq \frac{\delta q}{T}$
Entropy Change (Ideal Gas):

$$\Delta S = nC_v \ln\left(\frac{T_2}{T_1}\right) + nR \ln\left(\frac{V_2}{V_1}\right)$$

Gibbs Free Energy: $G = H - TS$
$dG = Vdp - SdT$
Maxwell Relations:

- $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial p}{\partial S}\right)_V$
- $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial p}{\partial T}\right)_V$

Quantum Chemistry

Photon Energy: $E = h\nu = \frac{hc}{\lambda}$
De Broglie: $\lambda = \frac{h}{p} = \frac{h}{mv}$
Heisenberg Uncertainty: $\Delta x \Delta p \geq \frac{\hbar}{2}$
Schrödinger Equation (Time-Indep.):

$$\hat{H}\psi = E\psi \implies \left(-\frac{\hbar^2}{2m}\nabla^2 + V\right)\psi = E\psi$$

Particle in a 1D Box (length L):

$$E_n = \frac{n^2 h^2}{8mL^2}, \quad \psi_n = \sqrt{\frac{2}{L}} \sin\left(\frac{n\pi x}{L}\right)$$

Gases & Solutions

Ideal Gas Law: $pV = nRT$
Van der Waals Equation:

$$\left(p + a\frac{n^2}{V^2}\right)(V - nb) = nRT$$

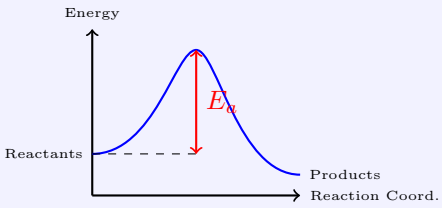
Raoult's Law: $P_A = x_A P_A^\circ$
Colligative Properties:

- Freezing Pt Dep: $\Delta T_f = iK_f m$
- Boiling Pt Elev: $\Delta T_b = iK_b m$
- Osmotic Pressure: $\Pi = iMRT$

Chemical Kinetics

First-Order: $\ln[A] = \ln[A]_0 - kt$, $\quad t_{1/2} = \frac{\ln 2}{k}$
Second-Order: $\frac{1}{[A]} = \frac{1}{[A]_0} + kt$, $\quad t_{1/2} = \frac{1}{k[A]_0}$
Arrhenius Equation:

$$k = Ae^{-E_a/RT}$$



Electrochemistry

Faraday's Law: $Q = It = nF$
Standard Cell Potential:

$$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$$

Gibbs Free Energy & Potential:

$$\Delta G^\circ = -nFE^\circ_{\text{cell}}$$

Nernst Equation:

$$E = E^\circ - \frac{RT}{nF}\ln Q$$

At 298 K: $E = E^\circ - \frac{0.0592}{n}\log_{10} Q$