

1. Quantum Chemistry Atomic Structure

- **Planck's Law:** $E = h\nu = \frac{hc}{\lambda}$
- **De Broglie Wavelength:** $\lambda = \frac{h}{p} = \frac{h}{mv}$
- **Heisenberg Uncertainty Principle:** $\Delta x \cdot \Delta p_x \geq \frac{h}{2}$
- **Time-Independent Schrödinger Equation:** $\hat{H}\psi = E\psi$

2. Thermodynamics

- **First Law:** $\Delta U = q + w$
- **Expansion Work:** $w = - \int P_{ext} dV$
- **Enthalpy:** $H = U + PV$
- **Entropy Change:** $\Delta S = \int \frac{dq_{rev}}{T}$
- **Gibbs Free Energy:** $G = H - TS$
- **Criterion for Spontaneity:** $\Delta G_{T,P} < 0$
- **Temperature Dependence (Gibbs-Helmholtz):**

$$\left(\frac{\partial(G/T)}{\partial T} \right)_P = -\frac{H}{T^2}$$

3. Chemical Kinetics

- **Rate Law:** $\text{Rate} = k[A]^x[B]^y$
- **Arrhenius Equation:** $k = Ae^{-E_a/RT}$
- **Integrated Rate Laws:**
 - Zero Order: $[A]_t = -kt + [A]_0$
 - First Order: $\ln[A]_t = -kt + \ln[A]_0$
 - Second Order: $\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$
- **Half-life (First Order):** $t_{1/2} = \frac{\ln 2}{k}$

4. Electrochemistry

- **Cell Potential:** $E_{cell} = E_{cathode} - E_{anode}$
- **Gibbs Energy EMF:** $\Delta G = -nFE_{cell}$
- **Nernst Equation:**

$$E = E^0 - \frac{RT}{nF} \ln Q$$

- **Kohlrausch's Law:** $\Lambda_m^0 = \nu_+ \lambda_+^0 + \nu_- \lambda_-^0$

5. Solutions Colligative Properties

- **Raoult's Law:** $P_A = X_A P_A^0$
- **Elevation in Boiling Point:** $\Delta T_b = iK_b m$
- **Freezing Point Depression:** $\Delta T_f = iK_f m$
- **Osmotic Pressure:** $\Pi = iCRT$