

Final Topics

Chapter 13. Chemical Kinetics

Reaction Rate & Rate Law

- Identify factors that affect reaction rate.
- Use stoichiometry to convert from the rate of one substance to another for a given reaction.
- Determine reaction orders, the rate law and the rate constant, k , from Initial Rates data.
- Identify graphs for 0, 1st, and 2nd order reactions based on the Integrated Rate Law relationships.
- Use the 1st order Integrated Rate law & half-life relationship to solve for k , t , $t_{1/2}$, $[A]_t$ or $[A]_0$.

Collision and Transition State Theories

- Describe features of Collision Theory: KE of molecules, Activation Energy, and orientation of molecules.
- Identify Endothermic vs. Exothermic Potential Energy diagrams & identify the transition state, ΔH , E_a (forward), E_a (reverse), and the energy level for reactants and products.
- Use the Arrhenius Equation to solve for k_1 , k_2 , T_1 , T_2 or E_a .
- Describe how you can determine E_a graphically.

Reaction Mechanisms and Catalysts

- Identify catalysts & intermediates for a given reaction mechanism.
- Write the predicted rate law for the reaction based on knowing the reaction mechanism.
- Define mechanism terms: molecularity, elementary step, rate determining step, intermediate and catalyst.
- Describe the effect of a catalyst on the activation energy for a reaction.
- Identify fast and slow steps for multi-step Potential Energy diagrams.

Chapter 14. Chemical Equilibrium

Equilibrium Constant, K

- Know definition of equilibrium, law of mass action and other characteristics of K_c .
- Write equilibrium expression (K_c or K_p) for any homogeneous or heterogeneous reaction.
- Determine if $K_c = K_p$ for a given reaction; know relationship between K_c and K_p .
- Determine the new K_c for a reaction when a reaction is multiplied by a factor or reversed or when different reactions are added together.
- Predict the extent of reaction from the size of K_c .

Solving Equilibrium Problems

- Calculate K_c or K_p from equilibrium reactant and product concentrations.
- Calculate equilibrium amounts of reactants and products given K_c & initial amounts of reactants.

LeChatelier's principle and Reaction Quotient, Q

- Predict direction that an equilibrium reaction will shift given a change in concentration, P , V , or T .
- Calculate Q and determine the direction a reaction will proceed in to reach equilibrium.

Chapter 15. Acids and Bases

Bronsted Lowry Theory

- Identify Bronsted acids & bases and conjugate acid-base pairs.
- Predict products for B-L reactions & decide whether the reaction is reactant or product favored.

pH, acidity, and relative strength of acids and bases

- Identify strong acids and strong bases.
- Understand the relationship between $[H^+]$, pH & acidity of a solution.
- Calculate pH given the concentration for a strong acid or strong base solution.
- Calculate pH, $[H^+]$, $[OH^-]$, or pOH given one of these variables.

Weak Acid-Weak Base Equilibria and Salt solutions

- Write the hydrolysis reaction, and the K_a or K_b expression for a weak acid or weak base.
- Determine relative strengths of acids & bases from K_a , K_b values and convert between K_a and K_b values.
- Calculate the pH, K_a (or K_b), or % ionization, for a weak acid or weak base solution.
- Predict whether a salt solution will be acidic, basic or neutral.

Chapter 16. Acid-Base Equilibria and Solubility Equilibria

Common Ion Effect and Buffers

- Predict the effect on the pH if a common ion is added to a weak acid or weak base solution
- Identify pairs of compounds that can form a buffer solution.
- Calculate the pH of a buffer solution before and after adding excess acid or base.

Acid-Base Titration Curves and Problems

- Identify the 4 general types of titration curves and match a curve to a given acid and base.
- Estimate the pH at the equivalence point for any of the 4 types of curves.

- Calculate the pH at any point in an acid-base titration.

K_{sp}, solubility and precipitation

- Write the equilibrium dissolution reaction and the K_{sp} expression for any slightly soluble salt.
- Calculate K_{sp} given the solubility of the salt or the concentration of one of the ions.
- Calculate the molar solubility for a salt given K_{sp}.
- Calculate Q and compare to K_{sp} to predict whether a precipitate will form after mixing 2 solutions.

Common Ion Effect and Solubility

- Predict the effect on the solubility if a common ion is added to a slightly soluble salt.
- Calculate the solubility of a slightly soluble salt in the presence of a common ion.

Chapter 18. Entropy, Free Energy and Equilibria

- Know the first 3 laws of thermodynamics.

Entropy, measure of Randomness

- Predict the sign of the entropy change for a given process.
- Calculate the standard entropy change for a chemical reaction from provided S° values.

Gibbs Free Energy, Spontaneity and K

- Identify elements in their correct standard state where $\Delta H_f^\circ = 0$ & $\Delta G_f^\circ = 0$.
- Identify the chemical reaction associated with the standard free energy of formation for a compound
- Calculate the standard change in enthalpy, entropy or free energy for a reaction from provided information.
- Identify whether a reaction is spontaneous or nonspontaneous from its ΔG value.
- Predict how ΔG will change with temperature given the signs for ΔH and ΔS .
- Calculate the ΔG under nonstandard conditions: $\Delta G = \Delta G^\circ + RT \ln Q$
- Calculate ΔG° from K and perform the reverse operation: $\Delta G^\circ = -RT \ln K$

Chapter 19. Electrochemistry

Oxidation, Reduction

- Identify the substance oxidized, reduced, the oxidizing and reducing agents for a redox reaction.
- Determine the oxidation number for a specific atom.
- Balance oxidation-reduction reactions in acidic or basic solution.

Voltaic Cells and emf

- Identify strongest/weakest oxidizing, reducing agent from a list of reduction potentials.
- Determine which reaction occurs at the cathode and anode given the reduction potentials of 2 half reactions.
- For a given voltaic cell, describe the processes that occur at the anode, cathode, salt bridge and the directions of e⁻ movement.
- Calculate the emf of a cell given the E° values & determine if the reaction is spontaneous.

Nernst Equation & the Relationship between E° and K

- Interconvert E°, ΔG° and K for a given reaction.
- Use the Nernst Equation to calculate E, E°, or the [ion] under nonstandard conditions.

Quantitative Electrolysis Problems

- Calculate time, current or the amount of substance produced in an electrolysis reaction.

Chapter 23. Nuclear Chemistry

- Identify differences between nuclear reactions and chemical reactions.
- Know different types of decay: α , β and γ , positron and e⁻ capture.
- Predict products or reactants for α , β and other nuclear reactions.
- Identify relationship between stability of nuclides and even vs. odd numbers of protons and neutrons.
- Solve first-order rate law and half-life equation for time, A_t, k or t_{1/2}.

Equations to know - these are not provided:

$$\text{pH} = -\log [\text{H}^+] \qquad \text{pH} + \text{pOH} = 14 \qquad [\text{H}^+][\text{OH}^-] = 10^{-14} \qquad K_a \cdot K_b = 10^{-14}$$

$$\Delta H_{rxn}^\circ = \Sigma [n_{\text{products}} \Delta H_f^\circ (\text{products})] - \Sigma [n_{\text{reactants}} \Delta H_f^\circ (\text{reactants})]$$

$$\Delta S_{rxn}^\circ = \Sigma [n_{\text{products}} S^\circ (\text{products})] - \Sigma [n_{\text{reactants}} S^\circ (\text{reactants})]$$

$$\Delta G_{rxn}^\circ = \Sigma [n_{\text{products}} \Delta G_f^\circ (\text{products})] - \Sigma [n_{\text{reactants}} \Delta G_f^\circ (\text{reactants})]$$

$$E_{cell}^\circ = E_{red}^\circ (\text{cathode}) + E_{ox}^\circ (\text{anode}) \text{ where } E_{ox}^\circ (\text{anode}) = -E_{red}^\circ (\text{anode})$$