CH 223 LEARNING OUTCOMES

1. CHEMICAL EQUILIBRIUM

1. Describe the expression for Kc given the balanced equation for a reaction involving gases or aqueous solutions.
2. Calculate the value of Kc knowing the equilibrium concentrations of all species, or the original concentrations of all species and the equilibrium concentration of one species.
3. Calculate the value of Kc using the coefficient rule, the reciprocal rule, and the rule of multiple equilibria.
4. Describe the direction in which a chemical system will move to reach equilibrium using the value of Kc.
5. Determine the effect of a change in the number of moles, volume, or temperature upon the position of an equilibrium using Le Chatelier's Principle.
6. Describe the expression for Kp in an equilibrium system and relate Kp to Kc.

2. ACIDS AND BASES

1. Calculate $[H^+]$, $[OH^-]$, pH or pOH given three of the four quantities.
2. Write a net ionic equation to explain why a molecule, cation, or anion gives an acidic or basic solution.
3. Calculate Ka for a weak acid HB, given $[H^+]$ or pH of a solution prepared by dissolving HB in water to a known initial concentration.
4. Calculate $[H^+]$ given the initial concentration of a weak acid and the value of Ka.
5. Relate the value of Kb for a weak base to Ka for its conjugate acid.
6. Calculate $[OH^-]$ given the original concentration of a weak base and the value of Kb.
7. Predict whether a specific ion or ionic compound will give an acidic, basic, or neutral solution.
8. Identify the Bronsted acid and Bronsted base or the Lewis acid and Lewis base and the conjugate acid-base pairs for a given acid-base reaction.

3. ACID-BASE AND PRECIPITATION EQUILIBRIA

1. Calculate the pH of a buffer system before and after the addition of known amounts of strong acid or base.
2. Determine the proportions in which a weak acid and its conjugate base should be mixed to give a buffer of specified pH.
3. Assemble an appropriate buffer system knowing the pKa values of weak acids.
4. Calculate the pH at any point in the titration of a strong base with a strong acid or a weak acid with a strong base or a weak base with a strong acid.
5. Calculate the equilibrium constant for a given acid-base reaction.
6. Determine the Ksp expression provided the formula of a slightly soluble ionic compound.
7. Determine the concentration of an ion in solution using the value of Ksp.
8. Determine if a precipitate will form when two solutions are mixed.
9. Calculate the solubility of an electrolyte in pure water or in a solution containing a common ion.

4. SPONTANEITY OF REACTION

1. Calculate ΔH and ΔS for a given reaction.
2. Calculate the free energy change for a reaction using the Gibbs-Helmholtz equation.
3. Calculate ΔG at 25 °C using free energies of formation.
4. Determine the temperature at which a reaction is at equilibrium given or having calculated ΔH and ΔS.
5. Describe how the signs of ΔH, ΔS, and ΔG relate to the spontaneity of a reaction.
6. Relate the standard free energy change for a reaction to the equilibrium constant.

5. ELECTROCHEMISTRY

1. Determine the oxidation number of each atom in a given formula
2. Balance a redox equation by the half equation method given the formulas of reactants and products.
3. Express the corresponding balanced equation in basic solution given a balanced equation or half-equation in acidic solution,
4. Contrast electrolytic with voltaic cells and identify anodes and cathodes in either type of cell and indicate the flow of current through all parts of the cell.
5. Calculate a cell voltage at standard concentrations using standard electrode potentials.
6. Recognize whether a given redox reaction will occur spontaneously at standard concentrations.
7. Calculate the voltage of a cell under non-standard conditions using the Nernst equation
8. Assess the products when an ionic salute is electrolyzed in water solution.
9. Relate the number of electrons or coulombs passing through an electrolytic cell to the amounts of products formed at the electrodes.
10. Relate the energy used in an electrolysis to the number of coulombs and volts.

6. COMPLEX IONS: COORDINATION COMPOUNDS & TRANSITION METALS

1. Describe general properties and reactions of transition metals.
2. Determine the oxidation number and coordination number of the central metal atom given the charge and composition of a complex ion.
3. Provide the correct name of a complex ion or coordination compound given the formula.
4. Demonstrate the geometry of a complex ion given its composition.
5. Relate the concentrations of free cation, complex ion and ligand given the formation constant for a complex ion,.