**Chemistry 30**

**Equilibrium - Chemical Equilibrium Focusing on Acid-Base Systems**

**Key Concepts and Learning Goals**

**Focusing Questions:** What is happening in a system at equilibrium? How do scientists predict shifts in

the equilibrium of a system? How do Brønsted–Lowry acids and bases illustrate equilibrium?

**Key Concepts:**

* chemical equilibrium systems
* Brønsted–Lowry acids and bases
* reversibility of reactions
* Le Chatelier’s principle
* titration curves
* conjugate pairs of acids and bases
* equilibrium law expression
* amphiprotic substances
* equilibrium constants *Kc*, *K*w , *K*a , *K*b
* buffers
* acid-base equilibrium
* indicators

**Learning Goal: You willexplain that there is a balance of opposing reactions in chemical equilibrium systems.**

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| **You Will:** | **Explanation/Definition:** (What is the concept?) | **Example:**(other than those from notes given in class) |
| 1. Define equilibrium and state the conditions that apply to a chemical system in equilibrium; i.e., closed system, constancy of properties, equal rates of forward and reverse reactions |  |  |
| 2. Identify, write and interpret chemical equations for systems at equilibrium |  |  |
| 3. Predict equilibrium shifts, using Le Chatelier’s principle, caused by the following stresses: changes in temperature, pressure, volume, concentration or the addition of a catalyst.  Describe how these changes affect the equilibrium constant. |  |  |
| 4. Define *Kc*to predict the extent of the reaction and write equilibrium-lawexpressions (*Kc)*for given chemical equations, using lowest whole-number coefficients |  |  |
| 5. Describe Brønsted–Lowry acids as proton donors and bases as proton acceptors |  |  |
| 6. Write Brønsted–Lowry equations, including indicators, and predict whether reactants or products are favoured for acid-base equilibrium reactions for monoprotic and polyprotic acids and bases |  |  |
| 7. Identify conjugate pairs and amphiprotic substances |  |  |
| 8. Define a buffer as relatively large amounts of a weak acid or base and its conjugate in equilibrium that maintain a relatively constant pH when small amounts of acid or base are added. |  |  |
| 9. analyze how equilibrium principles have been applied in industrial processes; e.g.,  Haber–Bosch process for producing ammonia  Solvay process for producing sodium carbonate  production of methanol. | | |
| 10. Design/Describe an experiment to show equilibrium shifts; *e.g., colour change, temperature change, precipitation* |  |  |
| 11. Analyze, qualitatively, the changes in concentrations of reactants and products after an equilibrium shift |  |  |
| 12. Interpret data from a graph to determine when equilibrium is established and todetermine the cause of a stress on the system |  |  |
| 13. Interpret, qualitatively, titration curves of monoprotic and polyprotic acids and bases for strong acid–weak base and weak acid–strong base combinations, and identify buffering regions |  |  |

**Learning Goal: You will determine quantitative relationships in simple equilibrium systems.**

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| **You Will:** | **Explanation/Definition:** (What is the concept?) | **Example:**(other than those from notes given in class) |
| 1. Recall the concepts of pH and hydronium ion concentration and pOH and hydroxide ion concentration, in relation to acids and bases |  |  |
| 2. Define *K*w , *K*a , *K*b and use these to determine pH, pOH, [H3O+] and [OH–] of acidic and basic solutions |  |  |
| 3. calculate equilibrium constants and concentrations for homogeneous systems and Brønsted–Lowry acids and bases (excluding buffers) when  concentrations at equilibrium are known  initial concentrations and one equilibrium concentration are known  the equilibrium constant and one equilibrium concentration are known. |  |  |
| **Other resources for Equilibrium Include:** | | |
| Vocabulary & Definitions for Unit: | | |