

Department of Chemistry  
CHM 1220/1225  
Exam IV Study Guide

**Coverage:** The exam covers Chapters 14, 15, and 16. It also covers content on any earlier exam that had <70% class average.

**Format:** The exam will be composed of eight problem-based questions (some may have more than one part) worth 15 points each and 6 multiple choice questions (worth 5 points each).

## Chapter 14: Chemical Equilibrium

### *Operational Skills*

- Applying stoichiometry to an equilibrium mixture.**  
Given the starting amounts of reactants and the amount of one substance at equilibrium, find the equilibrium composition.
- Writing equilibrium-constant expressions.**  
Given the chemical equation, write the equilibrium constant expression.
- Obtaining an equilibrium constant from reaction composition.**  
Given the equilibrium composition, find  $K_c$ .
- Using the reaction quotient.**  
Given the concentrations of substances in a reaction mixture, predict the direction of reaction.
- Obtaining one equilibrium concentration given the others.**  
Given  $K_c$  and all concentrations of substances but one in an equilibrium mixture, calculate the concentration of this one substance.
- Solving equilibrium problems.**  
Given the starting composition and  $K_c$  of a reaction mixture, calculate the equilibrium composition.
- Applying LeChatelier's principle.**  
Given a reaction use Le Chatelier's principle to decide the effect of adding or removing a substance, changing the pressure, or changing the temperature.

### *Suggested Self-Assessment and Review*

#### *Questions, p. 612-613*

14.4, 14.5, 14.7, 14.8, 14.9, 14.10, 14.12,  
14.13, 14.14, 14.15, 14.16

#### *Suggest Concept Explorations, p. 613-614*

14.17

#### *Suggested Conceptual Problems, p. 614-615*

14.19, 14.20, 14.22, 14.23, 14.24, 14.25,  
14.26

### *Suggested Strategy Problems, p.621-622*

14.115, 14.116, 14.118, 14.120, 14.121,  
14.122, 14.123

### *Suggested Cumulative-Skills Problems, p. 622*

14.125, 14.126, 14.127, 14.128

### *Suggested ACE Practice Test Problems*

14-1: 1-3, 6-11, 13-20;  
14-2: 1-5, 11-14;  
14-3: 3-20

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## Chapter 15: Acids and Bases

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### Equations

$$\begin{array}{lll} \text{pH} = -\log[\text{H}_3\text{O}^+] & [\text{H}_3\text{O}^+] = \frac{K_w}{[\text{OH}^-]} & [\text{OH}^-] = \frac{K_w}{[\text{H}_3\text{O}^+]} \\ \text{pOH} = -\log[\text{OH}^-] & [\text{H}_3\text{O}^+] = 10^{-\text{pH}} & [\text{OH}^-] = 10^{-\text{pOH}} \end{array}$$

### Given

Table 15.2 will be given if needed.

### Operational Skills

- Identifying acid and base species.** Given a proton-transfer reaction, label the acids and bases, and name the conjugate acid-base pairs.
- Identifying Lewis acid and base species.** Given a reaction involving the donation of an electron pair, identify the Lewis acid and the Lewis base.
- Deciding whether reactants or products are favored in an acid-base reaction.** Given an acid-base reaction and the relative strengths of acids (or bases), decide whether reactants or products are favored.
- Calculating concentrations of  $\text{H}_3\text{O}^+$  and  $\text{OH}^-$  in solutions of strong acid or base.** Given the concentration of a strong acid or base, calculate the hydronium-ion and hydroxide-ion concentration.
- Calculating the pH from the hydronium-ion concentration, or vice-versa.** Given the hydronium-ion concentration, calculate the pH; or given the pH, calculate the hydronium-ion concentration.

### Suggested Self-Assessment and Review

#### Questions, p. 645

15.1, 15.3, 15.4, 15.5, 15.8, 15.9, 15.10,  
15.11, 15.12, 15.13, 15.14, 15.15, 15.16,  
15.17, 15.18

#### Suggest Concept Explorations, p. 645-646

15.19, 15.20

#### Suggested Conceptual Problems, p. 646

15.21, 15.22, 15.24, 15.25, 15.26, 15.27,  
15.28

#### Suggested Strategy Problems, p.650-651

15.113, 15.114, 15.117, 15.118, 15.119,  
15.120, 15.121, 15.122

#### Suggested Cumulative-Skills Problems, p. 651

15.125, 15.126

#### Suggested ACE Practice Test Problems

15-1: 1-5, 9-10, 14-20;  
15-2: 1-20;  
15-3: 1-20

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## Chapter 16: Acid-Base Equilibria

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### Equations

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$K_b = \frac{[B^+][OH^-]}{[B]}$$

$$K_a K_b = K_w \text{ for conjugates}$$

### Given

Tables 16.1 and 16.2. Values of R will be given.

### Operational Skills

- Weak acids and weak bases.** Write the equilibrium reaction and equilibrium expression for weak acids and weak bases.
- Determining  $K_a$  or ( $K_b$ ) from the solution pH.** Given the molarity and pH of a solution of a weak acid, calculate  $K_a$  for the acid. The  $K_b$  can be determined in a similar way.
- Calculating concentrations of species in a weak acid solution using  $K_a$ .** Given  $K_a$ , calculate the hydronium-ion concentration and pH of a solution of a weak acid of known molarity.
- Calculating concentrations of species in a weak base solution using  $K_b$ .** Given  $K_b$ , calculate the hydronium-ion concentration and pH of a solution of a weak base of known molarity.
- Predicting whether a salt solution is acidic, basic, or neutral.** Decide whether an aqueous solution of a given salt is acidic, basic, or neutral.
- Obtaining  $K_a$  from  $K_b$  or  $K_b$  from  $K_a$ .** Calculate  $K_a$  for a cation or  $K_b$  for an anion from the ionization constant of the conjugate base or acid.
- Calculating concentrations of species in a salt solution.** Given the concentration of a solution of a salt in which one ion hydrolyzes, and given the ionization constant of the conjugate acid or base of this ion, calculate the  $H_3O^+$  concentration.
- Calculation the common-ion effect on acid ionization.** Given  $K_a$  and the concentrations of weak acid and strong acid in a solution, calculate the degree of ionization of the weak acid. Given  $K_b$  and the concentrations of weak acid and its salt in a solution, calculate the pH.
- Calculating the pH of a buffer from given volumes of solution.** Given concentrations and volumes of acid and conjugate base from which a buffer is prepared, calculate the buffer pH.

### Suggested Self-Assessment and Review

#### Questions, p. 690

16.1, 16.2, 16.5, 16.8, 16.9, 16.10, 16.11,  
16.12, 16.13, 16.14, 16.15, 16.16, 16.17,  
16.18, 16.19, 16.20

#### Suggest Concept Explorations, p. 691

16.21, 16.22

#### Suggested Conceptual Problems, p. 691-692

16.23 through 16.32

#### Suggested Strategy Problems, p.697-698

16.115, 16.116, 16.118, 14,120, 16.121,  
16.122, 16.123

#### Suggested Cumulative-Skills Problems, p. 698

16.135-16.138, 16.143

#### Suggested ACE Practice Test Problems

16-1: 1-20;  
16-2: 1-13, 6-20;  
16-3: 1-5, 12, 15, 16, 19