Adult Basic Education

Science

Chemistry 3102B

Equilibrium/Acids and Bases

Study Guide

Prerequisite: Chemistry 3102A

Credit Value: 1

Text: *Chemistry*. Mustoe et al.; McGraw-Hill Ryerson, 2004

Chemistry Concentration

Chemistry 1102
Chemistry 2102A
Chemistry 2102B
Chemistry 3102A
Chemistry 3102B
Chemistry 3102C

Table of Contents

To the Student

I. Introduction to Chemistry 3102B

This course introduces you to the concept of equilibrium. In chemistry, equilibrium is not what it appears to be at the macroscopic level. You will find that chemical equilibria involve molecules changing back and forth between products and reactants. You will find that up to now, chemical systems have been treated simplistically as reactants forming products. This is often not the case and in fact there are often both reactants and products present at the same time.

You met the concepts of acids and bases in Chemistry 1102. You will meet them again in this course, but you will find that acid and base chemistry involves an equilibrium system and by understanding this system, you will have a much better understanding of acids, bases and their properties.

If you have not completed a study of logarithms in your mathematics courses, you will need to do so before progressing to the last unit of this course. Speak to your instructor so that you will be ready for the material in Unit 4.

In addition to your study guide and text, you will need a scientific calculator. As you work through each page of your study guide, you should ensure that your answers to the problems are correct and that you fully understand them, before proceeding to the next page.

You will have labs for this unit. Let your instructor know in advance that you are getting close to needing to do these labs. Each lab will require a written lab report, which will be evaluated as part of your course mark.

The textbook for this course is *Chemistry*, McGraw-Hill, Ryerson, 2004.

To the Student

II. Use of Science Study Guides

Before beginning this course, ensure you have the text and any other resources needed *(see the information in the Introduction to this course for specifics)*.

As you work through the Study Guide, you will see that it is divided according to the Units listed in the Table of Contents. When you open a unit it will have the following components:

Reading for this Unit:
Here you will find the chapters, sections and pages of the text you will use to cover the material for this unit. Skim the sections of the textbook, look at the titles of the sections, scan the figures and read any material in the margins. Once you have this overview of the unit, you are ready to begin. Do not be intimidated by the content. You will work through the text, section by section, gaining knowledge and understanding of the material as you go.

References and Notes	**Work to Submit**
This left-hand column guides you through the material to read from the text. Read any highlighted notes that follow the reading instructions. The symbols ▶▶ direct you to the questions that you should complete when finished a reading assignment.	You come across three (3) headings in this right-hand column. **Writing:** This section comprises your notes for the unit. Here you will find either written questions or references to specific questions or problems from your text. You may want to write out each question followed by the answer. This material should be checked by your instructor before moving onto the next unit. Mathematical problems should have their solutions checked as you go. **Laboratory:** This section indicates if there is a Core Lab that should be completed for the unit. Let the instructor know in advance that you will be ready for the lab. A lab report should be submitted for each Core Lab. Your instructor will provide guidelines as to how she or he wants the report written. **Assignment:** This section indicates if there is an assignment that should be completed for the Unit. The information in the "References and Notes" column will indicate how you obtain the assignment. These assignments frequently relate the science content to technology, society and the environment.

III. Recommended Evaluation

Written Notes	10%
Labs/Assignments	20%
Test(s)	20%
Final Exam *(entire course)*	50%
	100%

The overall pass mark for the course is 50%.

Unit 1 - Dynamic Equilibrium

To fulfill the objectives of this unit, students should complete the following:

Reading for this Unit: ***Chemistry***

Chapter 13: Introduction: page 488
Section 13.1: pages 489-493
Section 13.2: pages 494-499; 511

References and Notes	Work to Submit
See your instructor for an introduction to this topic.	**Writing:**
Read Section 13.1, pages 489-493. Then write answers for questions 1.1 and 1.3 ▶▶	1.1 Define dynamic equilibrium. 1.2 Give an example of a chemical system at equilibrium. 1.3 Name and explain the four conditions that are needed for equilibrium to be reached.
Read pages 494-496. Then write answers for questions 1.4 - 1.7 ▶▶	1.4 State the law of chemical equilibrium. 1.5 How do chemists indicate that a chemical equation is at equilibrium? 1.6 Explain what is meant by the equilibrium constant (K_c).
Note: ***Solids and liquids are not included in the equilibrium expression.*** ***The equilibrium constant will vary with temperature.***	1.7 a) What is the general equation used to express the value of the equilibrium constant? b) What does each letter in the equation represent? c) What do the square brackets indicate?

Unit 1 - Dynamic Equilibrium

References and Notes	Work to Submit
Note: *You will find the answers to all the Practice Problems in Chapter 13 on page 537. Make sure you understand how to do each problem and that you get the right answers before moving on.*	**Writing:**
Study the Sample Problem on page 496 before you do 1.8 ▶▶	1.8 Complete Practice Problems 1 - 5, page 497.
Study carefully the Sample Problem on page 498 before you do 1.9 ▶▶	1.9 Complete Practice Problems 6 - 10, page 499.
Read carefully page 511, "Qualitatively Interpreting the Equilibrium Constant" before you do 1.10 ▶▶	1.10 Copy and complete the following statements: When K > 1, _____ are favoured. When K ≈ 1, there are approximately _____ concentrations of reactants and products at equilibrium. When K < 1, _____ are favoured.
***See your instructor to find out which questions you should complete for review.*	

Unit 2 - Predicting the Direction of a Reaction

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: ***Chemistry***
Chapter 13: Section 13.3 pages 519-520: 526-527

References and Notes	Work to Submit
Read the section "Le Châtelier's Principle" on page 519-520. Then write an answer for question 2.1 ▶▶	**Writing:** 2.1 State Le Châtelier's Principle.
Read carefully pages 526-527 and study Table 13.2 Then write answers for questions 2.2 - 2.4 ▶▶	2.2 For each of the following changes, state in which direction the equilibrium will shift, toward the reactants or products: (i) **Increasing** the **reactant** concentration. (ii) **Decreasing** the **reactant** concentration. (iii) **Increasing** the **product** concentration. (iv) **Decreasing** the **product** concentration. (v) **Increasing** the temperature of an **exothermic** reaction. (vi) **Decreasing** the temperature of an **exothermic** reaction. (vii) **Increasing** the temperature of an **endothermic** reaction. (viii) **Decreasing** the temperature of an **endothermic** reaction.
Note: *A change in pressure (or volume) will affect only an equilibrium with an unequal number of moles of gaseous reactants and products. An increase in pressure always favours a shift toward the side with the lower total number of moles of gaseous particles.*	

Unit 2 - Predicting the Direction of a Reaction

References and Notes	Work to Submit
	2.3 (a) State in which direction the equilibrium will shift for each of the following, when there are **more** gaseous product than reactant molecules: (i) Increasing volume (ii) Decreasing volume (b)When there are **fewer** gaseous product than reactant molecules: (iii) Increasing volume (iv) Decreasing volume
	2.4 What effect does adding a catalyst have on the position of equilibrium?
Study carefully the Sample Problem, "Using Le Châtelier's Principle" on page 528 before you do questions 2.5 and 2.6 ▶▶	2.5 Complete Practice Problems 33-37 on pages 529-530.
	2.6 Complete questions 1-3 in the Section Review, page 533.
**See your instructor to find out what questions you should complete for review.	

Unit 3 - Properties and Definitions of Acids and Bases

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: ***Chemistry***

Chapter 14: Introduction: page 542 - 544
Section 14.1: pages 545 - 558

References and Notes

Referring to Section 14.1, pages 545 - 557, answer questions 3.1 - 3.6 ▶▶

Note:
You should be familiar with moles and stoichiometric calculations and the nature of solutions and expressing solution concentration from previous Chemistry courses. If you have forgotten these concepts, you should discuss this with your instructor and find out what work you should do for review before you begin this course.

Note:
The Arrhenius Theory is modified by acknowledging the role of water.

Note:
Water is an example of an amphoteric substance.

Work to Submit

Writing:

3.1 Write an operational definition for an acid and a base.

3.2 What is the restriction of an operational definition?

3.3 (a) State the Arrhenius Theory of Acids and Bases.
(b) Write an example of a dissociation reaction for an acid and a base according to Arrhenius theory.

3.4 Write equations to show the dissociation of an acid (sulfuric acid) and a base (ammonia, NH_3) according to the modified (modern) Arrhenius theory.

3.5 State the Bronsted-Lowry Theory of Acids and Bases.

3.6 Define:
(i) conjugate acid-base pair
(ii) conjugate acid
(iii) conjugate base

3.7 Define amphoteric.

Unit 3 - Properties and Definitions of Acids and Bases

References and Notes	Work to Submit
Study carefully the Sample Problems, "Conjugate Acid-Base Pairs" and "More Conjugate Acid-Base Pairs", pages 555-556. Then answer question 3.8 and 3.9 ▶▶	3.8 Compute Practice Problems 1-4, page 557. 3.9 Complete Practice Problems 1 - 4, page 557.
See your instructor to find out which questions you should do for review.	

Unit 4 - Acid/Base Calculations

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Chemistry*
Chapter 14: Section 14.2: pages 560 - 572

References and Notes	Work to Submit
Referring to pages 560 - 563, write answers for questions 4.1 - 4.6 ▶▶	**Writing:** 4.1 Define strong acid and weak acid. 4.2 Write the equation for dissociation of the strong acid $HClO_4$ (aq) 4.3 Write the equation for the dissociation of HNO_2 (aq). 4.4 Define strong base and weak base. 4.5 Write the equation for the dissociation of the strong base KOH (s) in water. 4.6 Write the equation for the dissociation of the weak base CO_3^{2-} in water.
Study carefully the Sample Problem on page 564 before you do 4.7 ▶▶	4.7 Complete Practice Problems 10 and 11 on page 564.
Referring to pages 564 - 565, write answers for questions 4.8 and 4.9 ▶▶	4.8 (a) Write the equation for the self-ionization of water. (b) Based on this equation, write the equilibrium constant expression for this reaction. 4.9 Define K_w (ion product constant for water).

Unit 4 - Acid/Base Calculations

References and Notes

Referring to pages 567 - 569, "The pH Scale: Measuring by Powers of Ten", (and checking the glossary), answer question 4.10 and 4.11 ▶▶

Note:
You must understand logarithms and know how to find them using your calculator in order to complete the rest of the work for this unit. Refer to Appendix D of the text, pages 841 - 842, to review this topic. See your instructor if you need extra practice.

Study carefully Table 14.7, page 568 and the Sample Problem, page 569 before you do 4.12 and 4.13 ▶▶

Note:
Make sure that you know how to use your calculator to find an antilog. Your Math instructor can help you with this.

Study carefully the Sample Problems on page 570 and 571 and read "Another Way to Find $[H_3O^+]$ and $[OH^-]$" on page 571 before you do 4.14 ▶▶

See your instructor to find out which questions you should do for review.

Work to Submit

4.10 Define the pH and pOH in terms of the base 10 logarithms of the respective ions.

4.11 What pH range is
(a) acidic
(b) basic
(c) neutral

4.12 Complete Practice Problems 16 - 19 on page 569.

4.13 What is the equation that relates pH and pOH?

4.14 Complete Practice Problems 20 to 25 on page 572.