

Module 6.4: Weak Acid/Weak Base Equilibria

Background

- Acids have a bad rep. People generally believe that if it is an acid, it is nasty stuff. Chemists understand that acids vary in strength. Most natural acids that we are exposed to are weak acids- acetic, formic, citric, oxalic, etc. Understanding the nature of weak acids and bases in water is important chemical knowledge.
 - Description: This module introduces weak acids and bases- those that only partially ionize in solution. The composition of these solutions are defined, and the use of a weak acid or weak base equilibrium constant to calculate pH and the concentration of other species in solution is demonstrated. The text readings and instructor slides for the text are provided. The Ninja Nerds provide several videos that do a nice job of explaining how to solve weak acid-weak base equilibrium problems.

Learning Objectives

By the end of this sub-module, students should be able to:

- LO 6.4.1 Write chemical equations for dissociation equilibria.
- LO 6.4.2 Write equilibrium constant expressions for weak acids and weak bases.
- LO 6.4.3 Perform calculations with acid-base equilibrium constants.

Prior Knowledge Review

- [Chemical Equilibrium Modules 5.1-5.3](#)
- [Strong and Weak Acids, Autoionization of Water, pH and pOH Scale. Modules 6.2-6.3](#)
 - Description: As may be expected, the fundamentals of equilibrium, acids and bases, and pH are important prior knowledge to have before working through this module.

Instructional Materials

Textbook Sections

- OpenStax: Chemistry Atoms First 2e
 - [Relative Strengths of Acids and Bases Section 14.3](#) (6.4.1 - 6.4.3)

Videos Resources

- [General Chemistry: Acids Bases Video \(22:30-30:20\)](#) (6.4.1, 6.4.2)
 - Description: This video discusses weak acid equilibria and pK_a and pK_b .
 - License: By Ninja Nerds, under a standard YouTube License.
- [Weak Acid Weak Base Calculation: Detailed \(0:00-15:00\)](#) (6.4.3)
 - Description: This video shows how to analyze a weak base equilibrium problem and how to calculate the pH of a weak base solution.
 - License: By Ninja Nerds, under a standard YouTube License.
- [Weak Acid Weak Base Calculations: Quicker \(15:00-29:30\)](#) (6.4.3)
 - Description: This video shows how to calculate the pH of a solution of the conjugate acid of a weak base.
 - License: By Ninja Nerds, under a standard YouTube License.

Other Resources

- OpenStax: Chemistry Atoms First 2e
 - [Instructor Google Slides](#) (6.4.1 - 6.4.3)
 - Description: These are slides to accompany the OpenStax text Section 14.3 Relative Strengths of Acids and Bases
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Activities and Assessments

Conceptual Activities

- Worksheet: [Weak Acid and Weak Base Equilibria](#) (6.4.1-6.4.3)
 - Description: Three weak acid or weak base problems are given on this worksheet to illustrate the starting information that might be given in a pH problem that requires equilibrium reaction analysis.
 - Teaching Tip: These problems are difficult for an introduction to this topic. The worksheet is best used as a class exercise or after students have seen problems of this nature.
 - Answer Key: [Answer Key Weak Acid and Weak Base Equilibria](#)
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Application Activities/Assessments

- OpenStax: Chemistry Atoms First 2e
 - [Sec 14.3 Relative Strengths of Acids and Bases Exercises #57, 58](#) (6.4.1, 6.4.2)
 - Description: These exercises require students to look up a K_a or K_b value for a given species and use the equilibrium constant of water to determine the ionization constant of the corresponding conjugate base or conjugate acid.
 - Teaching tip: Each problem has 6 species for the repetitive nature of this exercise. In addition some species are amphiprotic and the exercise indicates whether the species should be initially interpreted as an acid or a base. This is beneficial when linking to polyprotic acids.
 - Answer Key: [Answer Key OpenStax Exercises #57, #58](#).
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[Sec 14.3 Relative Strengths of Acids and Bases Exercises #56, 59 - 63](#) (6.4.1 - 6.4.3)

- Description: In this series of exercises, students determine equilibrium concentrations of reactants and products, determine solution pH or calculate a

K_a . These questions are acid-base calculation problems requiring analysis from several different perspectives.

- Teaching Tip: These exercises provide students good homework practice.
- Answer Key: [Answer Key OpenStax Exercises #59 - 63](#).
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