

## EXPERIMENT 11

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### Determination of the Equilibrium Constant for a Reaction

#### Background

Organic esters are formed in an acid-catalyzed condensation reaction between a carboxylic acid and an alcohol. Water is also produced. The reaction, called Fisher esterification, is an equilibrium process whose equilibrium constant can be calculated if one can determine the equilibrium concentrations of all species.



In this experiment, we will mix known amounts of the 2 reactants with a catalytic quantity of strong mineral acid. The mixture must be heated to reach equilibrium in a reasonable time. Periodically during the heating, we will withdraw a homogeneous sample of the reaction mixture and will find the concentration of acid in the solution by titration. When the concentration becomes constant (unchanged on 2 successive analyses) we assume the mixture has reached equilibrium. From the results of the titration, we can determine the equilibrium concentration of the carboxylic acid. Knowing all initial reactant concentrations and the equilibrium concentration of one component allows us to calculate all equilibrium concentrations. Then, from the equilibrium expression, we can solve for the equilibrium constant value of the reaction.

One simplification makes use of the fact that the reaction mixture's volume is essentially constant during the course of the reaction. Since the stoichiometry shows equal moles of reactants and products, volume cancels from the equilibrium expression. Thus, the  $K_{eq}$  expression simplifies to the mole ratio of each component at equilibrium.

#### PROCEDURE:

You may work in **pairs** for this experiment. An individual lab report should be submitted by each student.

#### Part I:

Stock bottles of ~0.2M NaOH will be provided. This base must be standardized. Use potassium hydrogen phthalate,  $\text{KHC}_8\text{H}_4\text{O}_4$  (KHP for short) as the primary standard.



- First, calculate the appropriate mass of KHP required to titrate ~30 mL of the ~0.2M base. Obtain a KHP sample and dissolve it in 25 mL of deionized water. Rinse and fill

# Determination Of An Equilibrium Constant

**J Spring**



## **Determination Of An Equilibrium Constant:**

**Determination of the Equilibrium Constant of the Reaction  $2\text{Al}(1) + \text{AlCl}_3(\text{g})$**  H. Mitani, 1967

**Determination of an Equilibrium Constant by Spectrophotometry** James M. Postma, Julian Roberts, Jr., J. Leland Hollenberg, 2000-01-15      **The Determination of Stability Constants** Francis J. C. Rossotti, Hazel Rossotti, 1961      **The Photometric Determination of the Equilibrium Constant for the Reaction  $\text{N}_2\text{O}_4(\text{g})$**  K. L. Churney, 1961      An Introduction to the principles of physical chemistry from the standpoint of modern atomistics and thermodynamics Edward Wight Washburn, 1915      *Exploring Chemical Analysis* Daniel C. Harris, 2005 Exploring Chemical Analysis teaches students how to understand analytical results and how to use quantitative manipulations preparing them for the problems they will encounter      **Journal of the Chemical Society** Chemical Society (Great Britain), 1921      The Manufacture of Sulphuric Acid (contact Process) Frank Douglas Miles, 1925      **The Ionization Constants of the Second Hydrogen Ion of Dibasic Acids ...** Elbert Edwin Chandler, 1908      **A Course of Instruction in the General Principles of Chemistry** Arthur Amos Noyes, Miles Standish Sherrill, 1917      **Determination of the Equilibrium Constant for an Enzyme Catalyzed Reaction** Karen Emily DeFazio, 1968      Reactivity and Affinity in Acetal Formation as Affected by Beta Substitution in the Alcohol John N. Street, 1926      **The Journal of Physical Chemistry**, 1924      *The Elements of qualitative chemical analysis v. 1* Julius Stieglitz, 1911      *British Abstracts*, 1929      **The Journal of Industrial and Engineering Chemistry**, 1920      Journal Iron and Steel Institute, 1927 Includes the institute's Proceedings      **The Volumetric Determination of Arsenic Acid ...** Rocco Fanelli, 1923      **Use of Fluorescent Heavy Metal Indicators to Determine Equilibrium Constants and to Visualize Metals in Chlamydomonas Reinhardtii Cells** Kimberly Marie Slinski, 2000      **Journal of Industrial and Engineering Chemistry**, 1920

## Decoding **Determination Of An Equilibrium Constant**: Revealing the Captivating Potential of Verbal Expression

In a time characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its capability to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Determination Of An Equilibrium Constant**," a mesmerizing literary creation penned with a celebrated wordsmith, readers set about an enlightening odyssey, unraveling the intricate significance of language and its enduring impact on our lives. In this appraisal, we shall explore the book's central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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