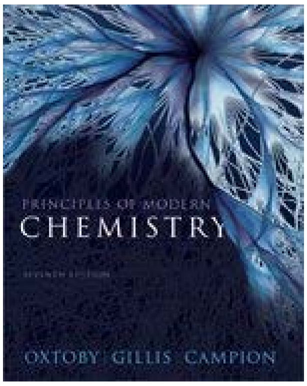
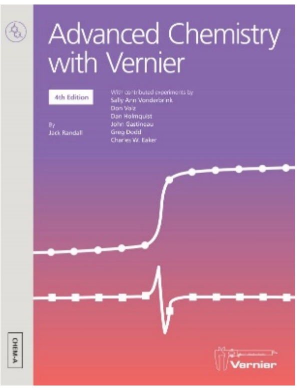
Material for Teaching

Principles of Modern Chemistry, 7th ed, Oxtoby/Gillis/Campion (Brooks/Cole)



(Auxiliary) Advanced Chemistry with Vernier



[Demo 수업 구성]

- 이론수업에서 개념 관련 이해를 돕기 위한 조교의 실험 DEMO 수행
- 실험을 통한 실시간 결과 확인 (대형 화면에 연결)
- 실험 결과/분석을 통한 개념 이해
- 질의응답을 통한 개념 습득 및 이해력 확장:
  수강생과의 Communication 를 통한 적극적 참여 유도

Acid-Base Titration (August 30)

Introduction

A titration is a process used to determine the volume of a solution that is needed to react with a given amount of another substance. In this experiment, your goal is to determine the molar concentration of two acid solutions by conducting titrations with a base of known concentration. You will be testing a strong acid, HCl, solution and a weak acid, $HC_2H_3O_2$, solution. You will use the sodium hydroxide, NaOH, solution that you standardized in Lab 6 as your base of known concentration. The reaction equations are shown below in net ionic form.

$$H^+ (aq) + OH^- (aq) \rightarrow H_2O (l)$$
$$HC_2H_3O_2 (aq) + OH^- (aq) \rightarrow H_2O (l) + C_2H_3O_2^- (aq)$$

The stoichiometry of the two reactions is identical; thus, your calculations will be straightforward. However, you will observe a significant difference in how the two acid solutions react with NaOH.

In this experiment, you will use a computer to monitor pH as you titrate. The region of most rapid pH change will then be used to determine the equivalence point. The volume of NaOH titrant used at the equivalence point will be used to determine the molarity of the HCl solution.

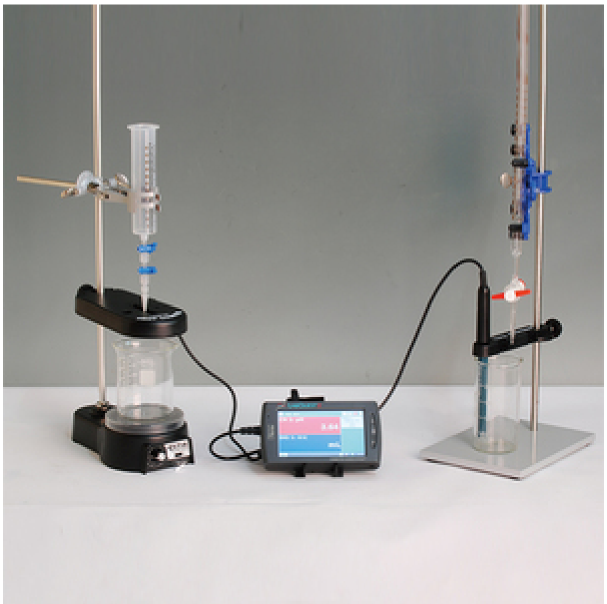
Objectives

In this experiment, you will

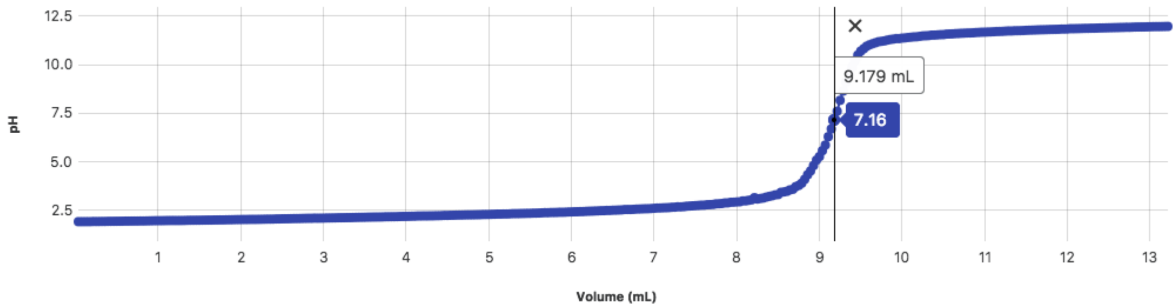
- Accurately conduct acid-base titrations.
- Determine the equivalence point of a strong acid-strong base titration.
- Determine the equivalence point of a weak acid-strong base titration.
- Calculate the molar concentrations of two acid solutions.

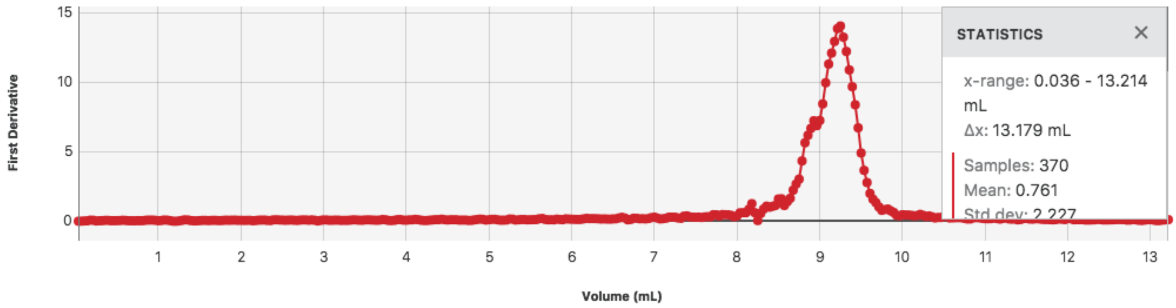
Sensors and Equipment

This experiment features the following Vernier sensors and equipment.



Sample Data





Video (Example)

https://vernier-videos.s3.amazonaws.com/training_html5/mp4/Acid-Base_Titration_(LabQuest).mp4

Determining the K_{sp} of Calcium Hydroxide (September 13)

Introduction

Calcium hydroxide is an ionic solid that is sparingly soluble in water. A saturated, aqueous, solution of $Ca(OH)_2$ is represented in equation form as shown below.

$$Ca(OH)_2\ (s) \leftrightarrow Ca^{2+}\ (aq) + 2OH^{-}\ (aq)$$

The solubility product expression describes, in mathematical terms, the equilibrium that is established between the solid substance and its dissolved ions in an aqueous system. The equilibrium expression for calcium hydroxide is shown below.

$$K_{sp} = [Ca^{2+}][OH^{-}]^2$$

The constant that illustrates a substance's solubility in water is called the K_{sp}. All compounds, even the highly soluble sodium chloride, have a K_{sp}. However, the K_{sp} of a compound is commonly considered only in cases where the compound is very slightly soluble and the amount of dissolved ions is not simple to measure.

Your primary objective in this experiment is to test a saturated solution of calcium hydroxide and use your observations and measurements to calculate the K_{sp} of the compound. You will do this by titrating the prepared $Ca(OH)_2$solution with a standard hydrochloric acid solution. By determining the molar concentration of dissolved hydroxide ions in the saturated $Ca(OH)_2$ solution, you will have the necessary information to calculate the K_{sp}.

Objectives

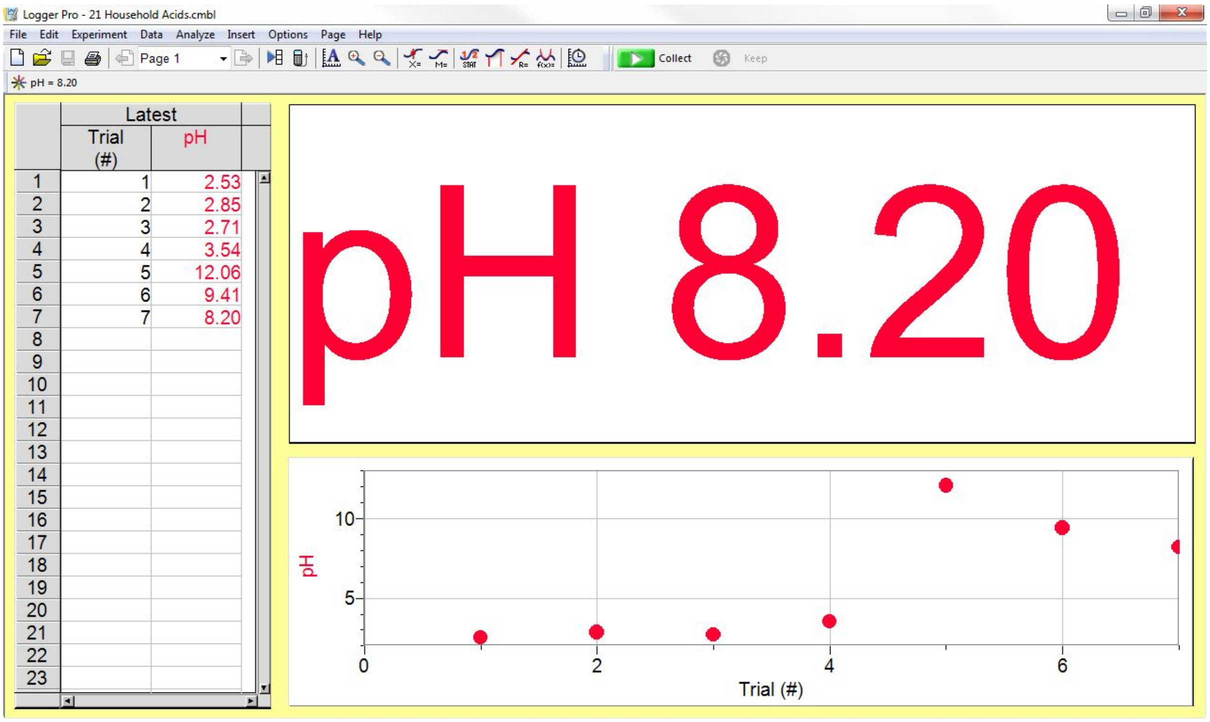
In this experiment, you will

- Titrate a saturated $Ca(OH)_2$ solution with a standard HCl solution.
- Calculate the K_{sp} of $Ca(OH)_2$.

Sensors and Equipment

This experiment features the following Vernier sensors and equipment.

Sample Data



Video (Example)

https://youtu.be/K0IcjlGQU3U

Electrochemistry: Voltaic Cells (September 20)

Introduction

In electrochemistry, a voltaic cell is a specially prepared system in which an oxidation-reduction reaction occurs spontaneously. This spontaneous reaction produces an easily measured electrical potential. Voltaic cells have a variety of uses.

In this experiment, you will prepare a variety of semi-microscale voltaic cells in a 24-well test plate. A voltaic cell is constructed by using two metal electrodes and solutions of their respective salts (the electrolyte component of the cell) with known molar concentrations. In Parts I and II of this experiment, you will use a Voltage Probe to measure the potential of a voltaic cell with copper and lead electrodes. You will then test two voltaic cells that have unknown metal electrodes and, through careful measurements of the cell potentials, identify the unknown metals. In Part III of the experiment, you will measure the potential of a special type of voltaic cell called a concentration cell. In the first concentration cell, you will observe how a voltaic cell can maintain a spontaneous redox reaction with identical copper metal electrodes, but different electrolyte concentrations. You will then measure the potential of a second concentration cell and use the Nernst equation to calculate the solubility product constant, K_{sp}, for lead iodide, PbI_2.

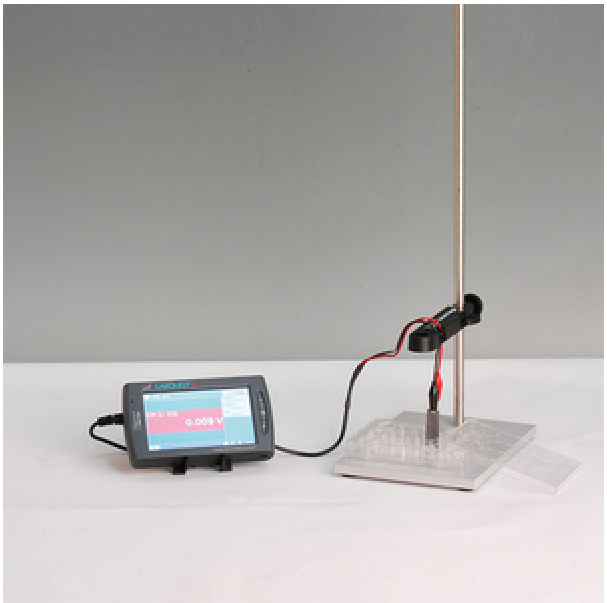
Objectives

In this experiment, you will

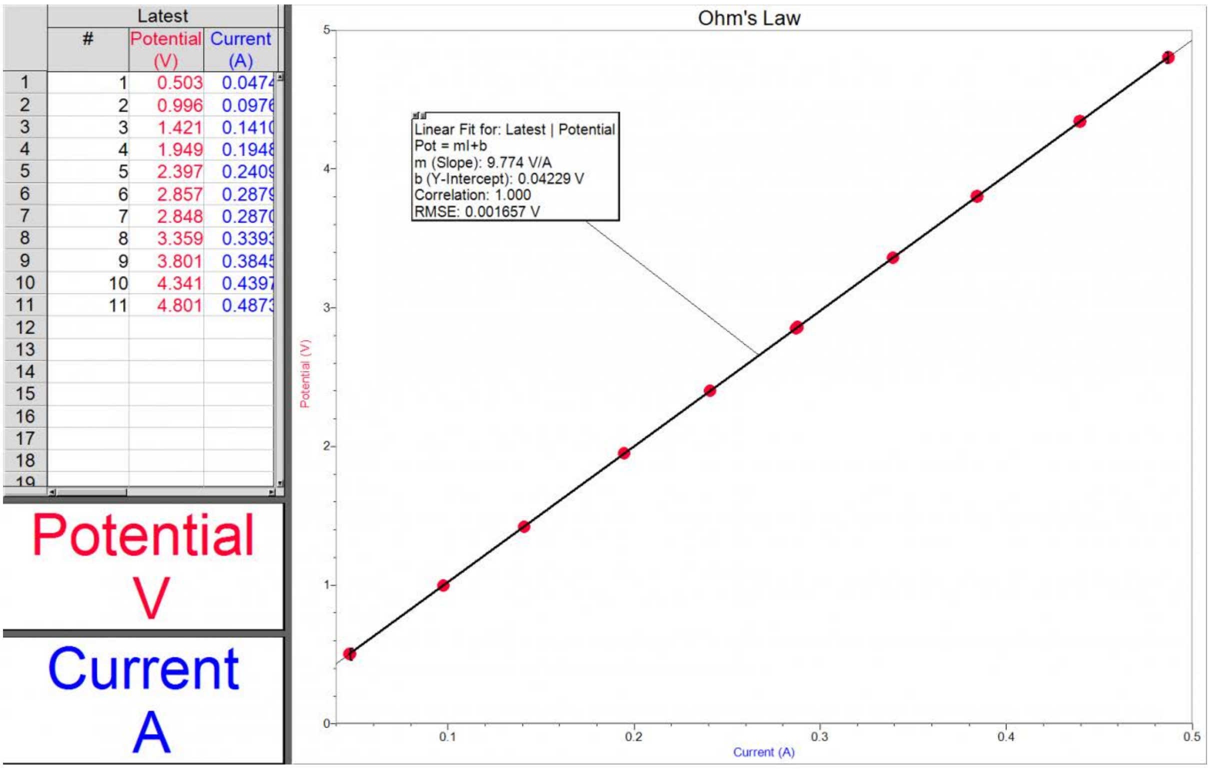
- Prepare a Cu-Pb voltaic cell and measure its potential.
- Test two voltaic cells that use unknown metal electrodes and identify the metals.
- Prepare a copper concentration cell and measure its potential.
- Prepare a lead concentration cell and measure its potential.
- Use the Nernst equation to calculate the K_{sp} of PbI_2.

Sensors and Equipment

This experiment features the following Vernier sensors and equipment.



Sample Data



Video (Example)

https://youtu.be/C26pH8kC_Wk

https://vernier-videos.s3.amazonaws.com/training_html5/mp4/Lemon_Juice_(LabQuest).mp4

Rate Determination and Activation Energy (October 4)

Introduction

An important part of the kinetic analysis of a chemical reaction is to determine the activation energy, E_a. Activation energy can be defined as the energy necessary to initiate an otherwise spontaneous chemical reaction so that it will continue to react without the need for additional energy. An example of activation energy is the combustion of paper. The reaction of cellulose and oxygen is spontaneous, but you need to initiate the combustion by adding activation energy from a lit match.

In this experiment you will investigate the reaction of crystal violet with sodium hydroxide. Crystal violet, in aqueous solution, is often used as an indicator in biochemical testing. The reaction of this organic molecule with sodium hydroxide can be simplified by abbreviating the chemical formula for crystal violet as CV.

$$CV^{+}\ (aq) + OH^{-}\ (aq) \rightarrow CVOH\ (aq)$$

As the reaction proceeds, the violet-colored CV^+ reactant will slowly change to a colorless product, following the typical behavior of an indicator. You will measure the color change with a Vernier Colorimeter or a Vernier Spectrometer. You can assume that absorbance is directly proportional to the concentration of crystal violet according to Beer's law.

The molar concentration of the sodium hydroxide, NaOH, solution will be much greater than the concentration of crystal violet. This ensures that the reaction, which is first order with respect to crystal violet, will be first order *overall* (with respect to all reactants) throughout the experiment. You will monitor the reaction at different temperatures, while keeping the initial concentrations of the reactants the same for each trial. In this way, you will observe and measure the effect of temperature change on the rate of the reaction. From this information you will be able to calculate the activation energy, E_a, or the reaction.

Objectives

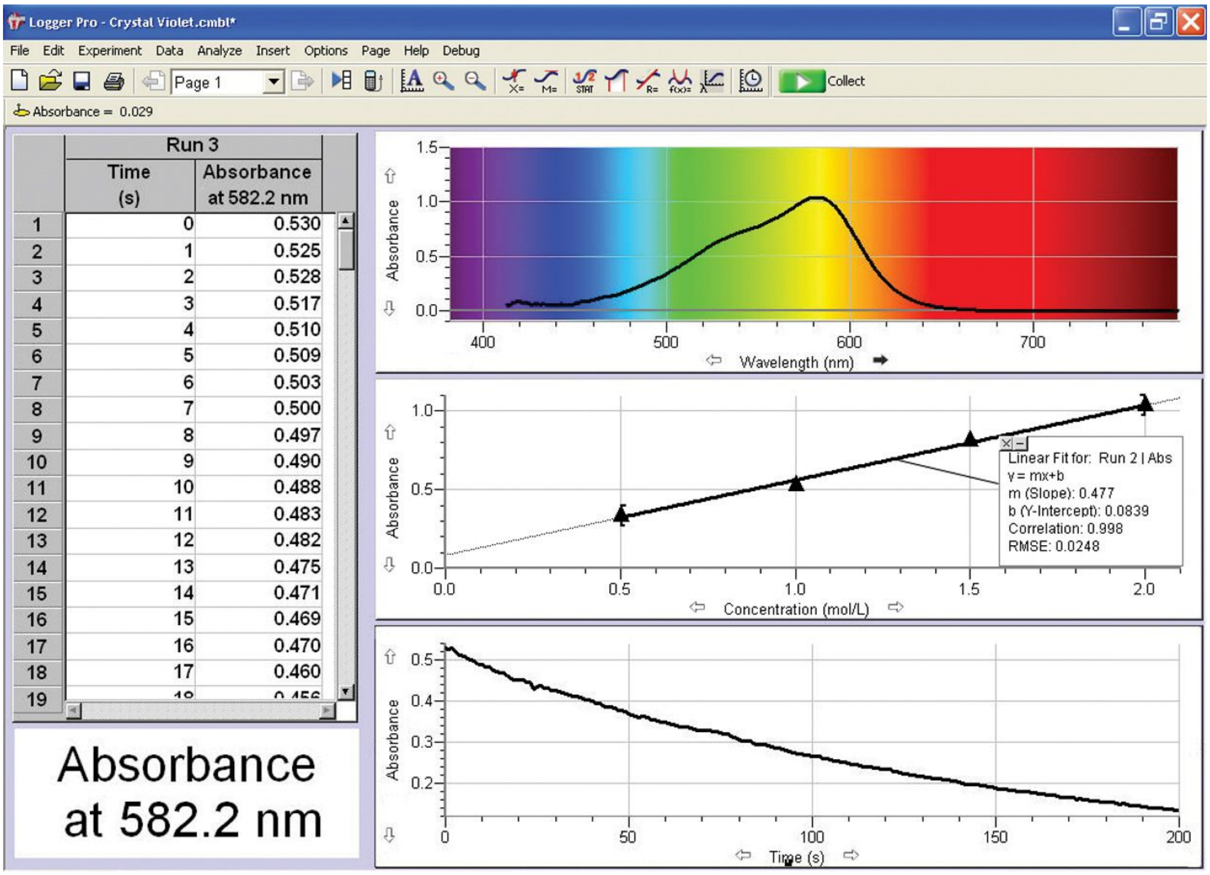
In this experiment, you will

- React solutions of crystal violet and sodium hydroxide at four different temperatures.
- Measure and record the effect of temperature on the reaction rate and rate constant.
- Calculate the activation energy, E_a, for the reaction.

Sensors and Equipment

This experiment features the following Vernier sensors and equipment.

Sample Data



Video (Example)

https://vernier-videos.s3.amazonaws.com/training_html5/mp4/video.svis-pl.labq2._tech-tips._jmelville.001.mp4