

TITRATION OF AN ACID MIXTURE

(#10.10)

The CCLI Initiative
Computers in Chemistry Laboratory Instruction

Learning Objectives

The objectives of this experiment are to ...

- analyze an acid mixture by titration with NaOH solution.
- use the **MicroLAB** interface to gather and store titration data.
- use the **MicroLAB** spreadsheet to graph the titration curve and accurately determine the equivalence points.

Background

In this experiment a solution containing either HCl and H₃PO₄, H₃PO₄ alone, or H₃PO₄ and NaH₂PO₄ is titrated using standardized NaOH solution. Progress of the titration will be followed using a pH electrode attached to a computer via the **MicroLAB** interface. From the data obtained, titration and first and second derivative curves will be constructed and the two acid concentrations will be determined.

Derivatives

It is often difficult to estimate precisely the equivalence point volume of an acid-base titration from the pH versus mL NaOH plot because it is difficult to determine where the slope of the curve reaches a maximum. Indicators may be chosen to give a good indication of the equivalence point, but they are never exactly accurate. A much more accurate method is to calculate the derivative of the titration curve. A discussion of the origin of first and second derivatives is given, and how these are used to determine the exact equivalence point by interpolation.

Experimental Procedure

- Students submit a clean, dry, and stoppered 50 mL Erlenmeyer flask to receive a sample of unknown.
- At least three aliquots of this are titrated with standardized NaOH solution.

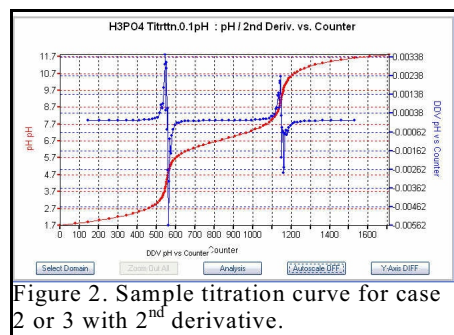


Figure 2. Sample titration curve for case 2 or 3 with 2nd derivative.

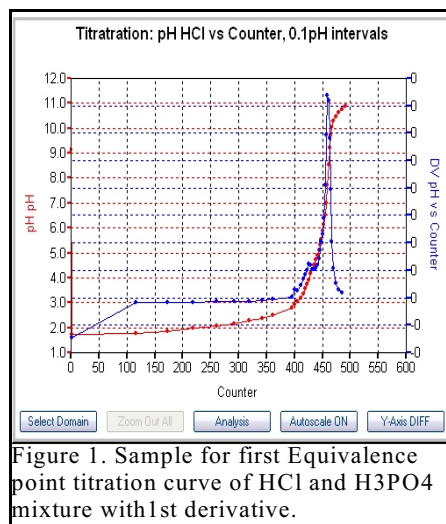
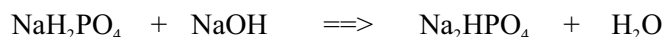
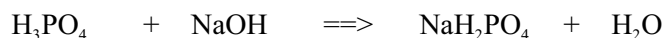
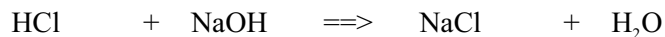


Figure 1. Sample for first Equivalence point titration curve of HCl and H₃PO₄ mixture with 1st derivative.

Data Analysis

- Depending on the composition of the mixture, two of the following reactions are possible:



- Students will calculate the amounts of either (1) HCl and H₃PO₄, (2) H₃PO₄ alone, or (3) H₃PO₄ and NaH₂PO₄ in the original unknown from the two equivalence point volumes obtained in the titration and calculate the molarities of the two acids in the original unknown (to the correct number of significant figures).

Instructor Resources Provided

- Sample Report Sheets providing the format to organize the data collection with sample data.
- Questions to consider, answer and turn-in with suggested answers.
- Tips and Traps section to assist the instructor with potential problems and solutions.
- Sample **MicroLAB** screen shots and graphs.
- Laboratory preparation per student station.