Exploring a pink-free alternative to the traditional titration!!

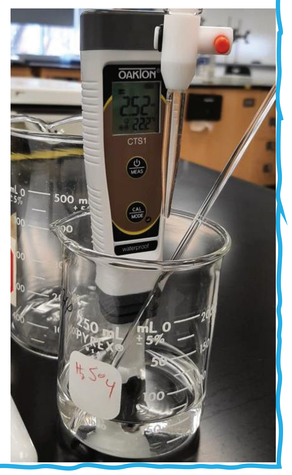
Asmaa Akbar, Abdulrahman kaki, Dr.Yibai Chen
Department of Chemistry, Penn State Abington University

PennState

Introduction

Often a good way to understand chemistry concepts is through doing experiments in the laboratory. Determining the concentration of a solution is important skill/knowledge learned in chemistry. In this project, we will compare two analytical techniques for determining the concentration of a solution; traditional titration that uses an indicator vs a method that employs a digital conductivity probe (using 3 unknowns). But what is titration exactly? Titration: is a chemical technique used in the lab to determine the concentration of a solution. As a chemistry student we always seek experiments that is accurate, simple, and plant the concept deep in our minds.

Vs

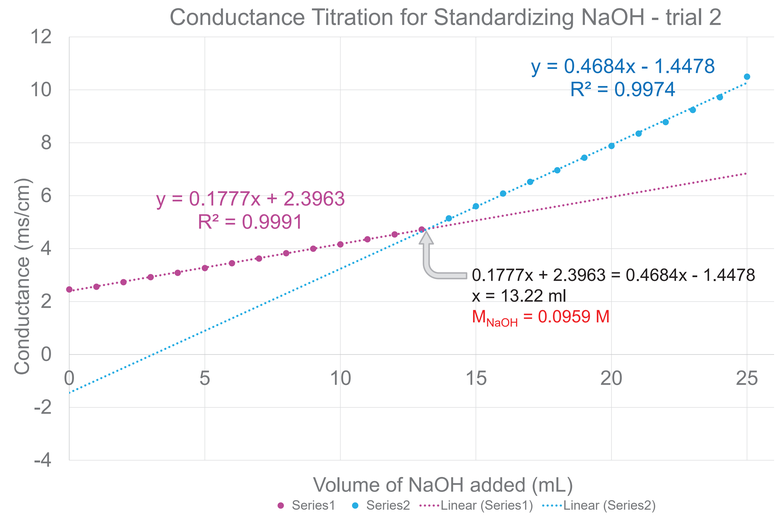


Research Questions.

We seek to answer two questions: 1) Do students learn the associated concepts better through a conventional technique or through a new technique that employs a digital probe?. 2) Do students get more accurate results with the new detection method, which has fewer opportunities for making measurement mistakes compared to the conventional titration method?

Methods (1,2,3)

- Our experiment target is to determine the percentage of KHP in 3 different unknown solutions with different KHP percentages.
- The method of the traditional titration is accomplished by delivering the titrant into the unknown solution that contains two drops of the indicator, until we see the pink color, where the pink color will appear at the equivalence point.
- The conductivity method is accomplished by delivering increments of 1mL of the titrant and recorded the corresponding conductivity for each mL added; then we plot a graph of the conductivity Vs the volume of NaOH.
- The point of intersection of the two straight lines will be the equivalence point as shown in the plot.



Data

Experimental results from titration using acid-base indicator

	trial 1	trial 2	trial 3	average	STD	measurement	company standard	percent error
molartiy of NaOH (M)	0.0977	0.100	0.0974	0.0984	0.001	0.098 ± 0.001	-	-
unknown 1 (#525) $mass_{KHP}$ %	59.1	58.1	58.6	58.6	0.5	58.6 ± 0.5	59.55	2
unknown 2 (#533) $mass_{KHP}$ %	51.3	51.8	52.3	51.8	1	51.8 ± 0.5	52.72	2
unknown 3 (#538) $mass_{KHP}$ %	38.7	36.0	44.1	39.6	4	40 ± 4	35.73	11

Experimental results from titration using EcoTestr CTS1 Pocket Tester

	trial 1	trial 2	trial 3	average	STD	measurement	company standard	percent error
molartiy of NaOH (M)	0.0989	0.0959	0.0975	0.0974	0.002	0.0974 ± 0.002	-	-
unknown 1 (#525) $mass_{KHP}$ %	59.6	59.9	59.5	59.7	0.2	59.7 ± 0.2	59.55	0
unknown 2 (#533) $mass_{KHP}$ %	53.2	54.2	53.6	53.7	0.5	53.7 ± 0.5	52.72	2
unknown 3 (#538) $mass_{KHP}$ %	38.2	38.7	35.1	37.3	2	37 ± 2	35.73	4

Method comparison

Advantages of the traditional method:
- somewhat faster than the conductivity test.
- cheaper.
- results are immediately available.

Advantages of the conductivity method:
- doesn't require any indicator, which if forgotten will destroy the whole experiment.
- more accurate than the conventional method because it doesn't involve any human judgment.
- this method can be used by color blind people.

Discussion & Conclusion

- For all the unknowns (#533, #538, and #525), the conductivity method gave a more accurate results, (lower percentage error).
- For the last unknown #538 we got somewhat higher percentage error compared to the previous unknowns. This is a consequence of the low percentage of KHP. Absorption of moisture by the non-KHP part of the sample will lead to an inaccurate weight. However, the percentage error of the conductivity method remains lower than the traditional titration methos.
- Students expressed no preference with respect to learning the concepts. The conductivity method is a more advanced method, in which concept is well embodied. The conventional method is a more of a basic method that you have to understand first. Ultimately, the choice of which method to use is dependent on your situation.

Literature cited

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3) K. Christopher Smith,* Etinosa Edionwe, and Bayyinah Michel; **Conductimetric Titrations: A Predict-Observe-Explain Activity for General Chemistry.** *J. Chem. Educ. 2010, 87, 1217−1221.*

Acknowledgments

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