Automated Spectrophotometric Titrations with EDTA Taking on all Metals

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Experimental automation has three components: experimental control, data acquisition and data analysis. Anyone who has been in a lab lately knows that control and acquisition are well handled by modern instrumentation. This statement is true, even for the off-the-rack and pieced together instrumental ensemble developed in our lab. In fact, it has great capabilities, including collection of full uv-visible spectra each second during the titration of 2 mL samples of analyte. Throw in ¼ wavelength resolution and one might drown in the flood of data produced by a 100 second titration. Fortunately, these experiments are the product of a marriage of Beers law and the metering capabilities of titrations. So the expectation that chemical accounting, charting the comings and goings of reactants and products is realistic, as is the ultimate assessment of exactly what it all means. To get to this happy state we need a powerful tool, and matrix algebra is exactly that. Better still, we don't even need to be up to speed with manipulation of matrices to extract and organize the information because the store-bought program ReactLab™, does it for us. So, top-to-bottom we have at hand an automated system developed to take out the tedium and allow us to arrive at chemical insights quickly.

What have we learned? Well, in our titrations of mixtures of Co^{2+}, Ni^{2+}, and Cu^{2+} with EDTA we have obtained excellent concentrations for each of these metal ions. This work was inspired by a published study[1] and instrumental analysis experiments adapted from it at Purdue University[2]. In order to get these results the EDTA complexes must be spectrally distinct or temporally separated — due to significant differences in formation constants, K_f's. All three complexes were spectrally distinct, while Co^{2+} also had a smaller K_f that caused it to react after Ni^{2+}, and Cu^{2+}. Since EDTA is the omnivore of ligands the possibilities of extending this work seem almost boundless. How many metal ions might be determined in a single mixture? How good is this method for speciation (determination of concentration of metals differing only in oxidation states)?...

If you are interested in taking on this expansionist roll please be assured that much is known about EDTA titrations and you don't need to look hard to find it, e.g. ref[3]. It will be your responsibility to take shared ownership of this project. It is expected that this work will produce reaction details worthy of presentation at a professional meeting, perhaps the 2015 Joint Southeast/Southwest Regional Meeting of the American Chemical Society in Memphis, Tennessee. After that, burn the plates, it's going to the journals.

[1]G. Dado, J. Rosenthal, J. Chem. Ed. 67 (1990) 797-800.

[2]www.chem.purdue.edu/courses/chm224/Lab-Experiments/Experiment6_plus apparatus.pdf

[3]Harris. *Quantitative Chemical Analysis* 8th ed. W. H. Freeman and Company. New York, 2010, Chapter 11, pgs. 236-255.