Week 10
Ion-exchange Chromatography

“Nothing happens until something moves.”

—Albert Einstein
Physicist

Chromatography is a very common technique in the chemical laboratory and possibly the most important technique you will learn in this course. The power of chromatography stems from its ability to separate materials based on rather small differences in chemical or physical properties. You have seen how thin-layer chromatography (TLC) relies on differences in intermolecular attractions to achieve separation. With this experiment you will see how equilibrium chemistry can be used for the same purpose with the technique known as ion-exchange chromatography.

Educational Objectives: A student who has successfully completed this experiment will be able to
- recharge an ion-exchange column,
- describe how an ion-exchange column works,
- determine the moles hydronium ion released by a column, and
- determine the total positive charge in a sample.

Experimental Objectives: A student who performs this experiment is asked to
- recharge a cation-exchange column with acid,
- run samples through the column collecting the elutant,
- determine the moles hydronium ion released by the column, and
- calculate the total positive charge in the sample.

Background
This is the second of three laboratory techniques you will use to create a “cationic profile” of your water samples. How these three techniques fit together is discussed in the Water Project pages in the syllabus. Before beginning the experiment you should be aware of how the data you will be collecting will mesh with the data provided by the other techniques to create the profile.

Column chromatography is a technique developed following the second world war to separate chemical substances based on differences in their chemical properties. There are many different kinds of column chromatography. The one introduced with this experiment, ion-exchange chromatography, is widely used to purify water. Depending on how the techniques is performed is can be used to soften hard water and to make deionized water. It is discussed in detail in chapter 6-3 and 6-4 of your technique book. You will need to review this material before continuing.

Overview
The problem put to your group is to determine the total positive charge of your water samples, the positive charge being the sum of the charges on all the cations in the sample. You will do this by using a cation exchange column to exchange all the positive ions for hydronium ions and then titrating the hydronium ions with your standardized NaOH solution. The activities required to determine the total positive charge in your samples can be summarized as follows:
Regenerate column.
Run samples through column.
Titrate samples.

**Procedure**
Details on performing the chromatography are given in section 6-4 of the technique book. Note that the book describes how to construct an ion-exchange column. You will not have to do this as the columns have already been constructed for you by the preproom. However, should a problem develop you may need to rebuild it.

**Worksheet**
There is no report assigned for this experiment. Instead, you are to complete a worksheet. Should you not complete the worksheet in lab it is expected you will turn it in to your TA’s drop box the next day.

**Worksheet**
You will need a worksheet to submit in class. A worksheet form is posted to the content section of D2L. You can print a copy of this or you can make a hand written copy. It is designed to be one sheet, two sides. Keep to this design.

**Data Analysis**
The final answer you need to obtain is $M_{PC}$, the molarity of positive charge in your sample. The governing equation for the experiment is equation 6-5 in the technique book.

$$\text{Moles PC in sample} = \text{moles H}_3\text{O}^+ \text{ released from the column}.$$  

The moles hydronium released by the column is determined by the titration. The moles PC in the sample can then be converted to a concentration by taking into account the volume of the sample.