

# Water Softening Laboratory: Isoke Baptiste

## Teacher's Guide

### Goals

- To learn about filtration and separation of solutions through water softening
- To learn the basics of chemistry through everyday phenomena

### About the Laboratory

The purpose of this laboratory is to learn about the chemistry of water hardness. The origin of water hardness is in the  $Mg^{+2}$  and  $Ca^{+2}$  cations present in tap water, which disturb the foaming of soaps. The purpose of the experiment is to introduce the chemistry of filtering and separation of ions from solutions through a well-known everyday topic, in order to facilitate the understanding of these topics.

### Materials for Each Group

- Filter paper
- 4 funnels with stands
- 100 g sand
- 100 g Calgon
- 100 g ion exchange resin Dowex 50 WX-8\*
- A spatula
- A 50 ml graduated cylinder
- A 250 ml beaker
- Four 50 ml plastic test tubes in racks
- Liquid soap solution + pipets
- Phenolphthalein indicator

\*Smaller amounts of Dowex can be packed into 5 ml pipette tips instead of funnels.

### SAFETY

Wear goggles at all times during the lab period.

Do not touch the ion exchange resin with your hands.

Do not throw the resin away—it can be washed and re-used.

### Lecture Notes

We are dealing with the amount of chlorine or other minerals such as magnesium that we find in water.

Why do we find these minerals in water?

Today's activity will be about water softening.

If you were in the shower and the water were too hard, your soap would not lather up and would not do its job.

### Teaching Tips From Isoke Baptiste

Having kids do chemistry and relate it to things that they see everyday definitely helps get them more intrigued by chemistry.

If you don't teach them things that they can relate to, then they will not be interested in it.

I would definitely recommend letting the students do first and correct later, because if you keep giving them what they need they will never learn along the way.

The experiment is a great reference point because when they start learning things that we talked about today they can immediately refer to that experiment.

Even though they didn't understand a lot of the terms that we used, once we go over it, they are able to see the process.

The good thing about the students coming to the experiment without prior knowledge was that they could bring their own outcomes. They had no clue what was supposed to happen so they were looking to do it correctly, and make sure they got the correct outcome.

The students were eager to do more labs and were more interested as far as measurements and seeing specific outcomes were concerned.

Some things that I would change: a prerequisite or a homework assignment. I would ask the students to gather different water samples. They could go to different friends' houses and different regions of D.C., just to get different samples. Add soap and see if there is any effect, and you don't even tell them what the outcome should be. Have them record their results, go to the experiment and see similarities between this and their homework assignment.

### Comment

1. There are commercial indicators for water hardness which may be useful for this activity.
2. It is possible to emphasize the role of the ion exchanger in filtration by measuring the pH of the water solution before and after the ion-exchange column. A way to emphasize the analytical aspect of this experiment is by analyzing the cations in solution with EDTA and indicator. For more advanced students, add also complexometric titrations, see reference: Ceretti, H.; Hughes, E. A.; and Zalts, A. (1999) "The Softening of Hard Water and Complexometric Titrations: An Undergraduate Experiment," *Journal of Chemical Education*, Vol. 76, No.10, pp: 1420-1421.
3. Discuss distillation as a method for separation of cations from water. Demonstrate distillation of wine to illustrate.
4. Discuss zeolites in laundry powder and their water-softening property: *Journal Staff* (1999) "Cleaning Up With Chemistry: Investigating the Action of Zeolite in Laundry Detergent," *Journal of Chemical Education*, Vol. 76, No.10, pp: 1416A-1416B.

### References: Links

<http://www.ianr.unl.edu/pubs/housing/g946.htm>

A guide to water softeners for the home.

<http://www.saltinstitute.org/42a.html>

A unit of study built around salt. Scroll down the page and click on "Unit 4" for a one-period class activity on water softening from the Salt Institute.

### References: Readings

Ceretti, H., Hughes, E.A., and Zalts, A. (1999) "The Softening of Hard Water and Complexometric Titrations: An Undergraduate Experiment," *Journal of Chemical Education*, Vol. 76, No. 10, p: 1420.