

Water Softening Laboratory:

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Students' 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 solution through a well-known everyday issue, 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 + pipete
- 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.

Instructions

1. Put funnels in stands and test tubes in a rack beneath them.
2. Put a piece of round filter paper in each funnel.
3. Leave one funnel empty, and put in the other three: sand, Calgon, and ion exchange resin, almost filling the filter paper in the funnel.

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If you are using a 5 ml tip for the Dowex, pack it up lightly, after inserting a small piece of absorbing paper in its lower end.

4. Measure 10 ml of hard water and filter it through one funnel. Repeat this for all funnels.
5. When the water stops dripping into the test tube, add several drops of liquid soap solution to it and shake well. Notice what happens and record your observations:
 - a. Filter paper only: _____
 - b. Filter paper and sand: _____
 - c. Filter paper and Calgon: _____
 - d. Filter paper and resin: _____
6. What chemical principles are responsible for these phenomena? _____

7. How did the use of each filter influence the hardness of the water? Explain the filtering properties of:
 - a. Filter paper only: _____
 - b. Filter paper and sand: _____
 - c. Filter paper and Calgon: _____
 - d. Filter paper and resin: _____
8. Which filters are physical filters only and which have also chemical properties? _____

9. Which filter is the most effective for water softening? How does it filter the Mg^{+2} and Ca^{+2} cations? _____

10. Which filter serves as control? Why? _____

11. Based on the understanding of ion-exchange filtration, suggest another way to learn about the cation concentration in the original water solution: _____

12. Filter another sample of water on the ion exchange column. Add several drops of universal indicator to both water solutions: before and after filtration. Shake well, and observe what color you get. Explain:

Summary

Why do we put Calgon in our washing machines? _____

