

Comparing Hard and Soft Water

As water flows through the ground, some of the minerals that make up rocks and soils can dissolve and become held in solution. Two minerals that are commonly held in solution are calcium carbonate (CaCO_3) and magnesium carbonate (MgCO_3). High concentrations of calcium and magnesium, together with certain dissolved sulfates, contribute to “hard” water. While it’s not a health hazard, hard water can leave spots and films on glasses, shower doors, sinks, tubs, and faucets. Hard water can also clog pipes and spigots and can interfere with the effectiveness of certain soaps and detergents. In this laboratory activity, you will test several different samples of water to determine the relative hardness of each and observe how borax (sodium borate, $\text{Na}_2\text{B}_4\text{O}_7$) can soften hard water. You will then infer why hard water can be harmful to some household appliances but can possibly be good for your health.

OBJECTIVES

Compare and **contrast** the relative hardness of several samples of water.

Observe how borax can soften water.

Explain some of the problems associated with hard water.

Infer some of the benefits of both hard and soft water.

MATERIALS

- baby food jars, large, clean, with lids (6)
- borax
- distilled water
- eyedropper
- graduated cylinder
- lab apron
- liquid soap
- water samples (6): cold tap water, hot tap water, distilled water, rainwater, local stream or pond water, salt water
- marker, permanent, fine-lined
- metric ruler
- paper towels
- safety goggles
- tape, masking
- watch or clock with second hand



Procedure

PART I—RELATIVE HARDNESS OF VARIOUS WATER SAMPLES

1. Put on your safety goggles and your lab apron. Use the paper towels to immediately wipe up any spills onto your work area or the floor.
2. Tear 6 pieces of masking tape, each about 2.54 cm in length. Secure one piece onto the outside of each jar.

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3. Use the permanent marker to label each piece of tape with one of the following: *cold tap water*, *hot tap water*, *distilled water*, *rainwater*, *stream or pond water*, and *salt water*.
4. Use the graduated cylinder to add 50 mL of each type of water to the appropriate jar. **CAUTION: Use care when collecting and working with the hot tap water.**
5. Observe the clarity of each water sample and record your observations in the table.
6. Use the eyedropper to add 5 drops of the liquid soap to one of the jars of water. Close the jar tightly and shake it for 20 seconds.
7. Put the jar on a flat surface and measure the height of the suds (lather) above the water line. Record your measurement in the appropriate space in Table 1.
8. Repeat steps 6 and 7 for each of the other water samples.
9. Empty and examine the inside of each jar. In the table, note whether or not a film was present on the inside of each jar.

Relative Hardness of Various Local Water Samples

Type of Water	Water Clarity before Shaking	Height of Suds above Water Line	Film on Jar?
Cold Tap Water			
Hot Tap Water			
Distilled Water			
Rainwater			
Stream or Pond Water			
Salt Water			

PART II—BORAX: A COMMON WATER SOFTENER

10. Thoroughly rinse the jar labeled “salt water” with some distilled water.
11. Add 50 mL of salt water and 1 mg of borax to the clean jar. Shake the jar for 30 seconds or more to dissolve the borax.
12. Use the eyedropper to add 5 drops of the liquid soap to the jar. Close the jar tightly and shake it for 20 seconds.
13. Put the jar on a flat surface and measure the height of the suds (lather) above the water line. Compare this measurement to the suds height in the salt water jar that contained no borax.

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Analysis

- 1. Examining Data** Rank the water samples tested from softest to hardest based on the amount of suds produced in each jar.

- 2. Explaining Events** What effect did the borax have on the salt water?

- 3. Describing Events** In which jars did the water-soap solution leave a film? Hypothesize why this happened.

Conclusions

- 4. Interpreting Information** Based on your results, what are some of the benefits of soft water?

- 5. Applying Conclusions** In homes which have hard water, minerals including calcium and magnesium can precipitate out of the water and stick to hard surfaces inside appliances. Make a list of home appliances which hold water, either permanently or temporarily, which might be affected by hard water.

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6. Interpreting Information What effect does hard water likely have on the life span of an appliance?

7. Applying Conclusions How might hard water be beneficial to a person's health?

8. Applying Conclusions Packaged water softeners contain sodium. How might these softeners affect a person's health?
