

Hands-On Science



Water

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Contents

<i>To the Teacher</i>	v
<i>National Science Education Standards Correlations</i>	vi
<i>General Rubric</i>	xvi
1. Which Scientific Tools and Instruments Do We Use to Learn About Water?	1
2. Observing the Properties of Water: How Do Ships Float?	8
3. Can You Make a Cartesian Diver?	15
4. What Makes Up a Water Molecule?	22
5. Why Is It Difficult to Wash with Hard Water?	29
6. When Can Water Carry an Electric Current?	36
7. Investigating the Differences Between Solutions and Suspensions	43
8. Investigating the Heat of Fusion of Ice	50
9. How Does Water Act Like a Lens?	57
10. Does Cold Water Weigh the Same As Hot Water?	62
11. How Can We Save Water?	69
12. A Study of Water Under Pressure	75
13. Investigating Salt Melting Ice	82
14. Investigating Osmosis in Living Cells	88
15. What Evidence Is There That Water Molecules Stick Together?	97
16. How Can You Make Your Own Cloud?	102
17. How Does Salt Affect Water's Boiling Point?	109
18. Who Wins the Paper-Towel Race?	116
19. How Can We Determine the Solubility of Salt in Water?	123
20. How Can Pressure Affect the Freezing Point of Ice?	131
<i>Glossary</i>	137

5. Why Is It Difficult to Wash with Hard Water?

TEACHER RESOURCE PAGE



INSTRUCTIONAL OBJECTIVES

Students will be able to:

- record observations
- draw conclusions based on data
- record data in a data table



NATIONAL SCIENCE EDUCATION STANDARDS CORRELATIONS

GRADES 5–8

Content standard	Bullet number	Content description	Bullet number(s)
A	1	Abilities necessary to do scientific inquiry	1–7
A	2	Understandings about scientific inquiry	1–5
D	1	Structure of the earth system	6, 7

GRADES 9–12

Content standard	Bullet number	Content description	Bullet number(s)
A	1	Abilities necessary to do scientific inquiry	1–5
A	2	Understandings about scientific inquiry	3, 5
B	1	Structure of atoms	1
B	2	Structure and properties of matter	3, 4



VOCABULARY

- **hard water:** water that contains dissolved mineral ions of either calcium or magnesium
- **ions:** atoms that have gained or lost electrons
- **water softener:** substance that combines with and removes the mineral ions that make water hard

5. Why Is It Difficult to Wash with Hard Water?

TEACHER RESOURCE PAGE



MATERIALS

Per group:

- medicine droppers
- ten 25-ml test tubes
- test-tube rack
- distilled water
- hard water
- tap water
- 1% laundry detergent
- 1% soap solution
- water softener (sodium tetraborate or trisodium phosphate)
- crayon pencil
- 50-ml graduated cylinder
- two 100-ml beakers
- stopwatch, watch, clock, or other timing device

HELPFUL HINTS AND DISCUSSION

Time frame: one class period

Structure: groups of four students

Location: classroom

In this activity, students will test three types of water to discover the difference in sudsing ability between hard and soft water. Students will record the differing amounts of detergent needed to create soapsuds in tap water, hard water, and distilled water. They will be asked to give reasons for the different results. Students must be told how to make soft water hard in order to do Part 2 if their tap water is not hard. In addition, students will add water softeners to samples of hard water and repeat the test for suds. Students will be asked to compare the results and provide an explanation for their observations.

MEETING THE NEEDS OF DIVERSE LEARNERS

Students who need extra challenges should complete the Extension Option and the Follow-Up Activities. These students should be able to share their understanding of the various properties of hard and soft water.

Organize cooperative-learning groups that include students of different abilities. Some students might need a review of the procedure to keep the various samples of water separated.

SCORING RUBRIC

Students meet the standard for this activity by:

- demonstrating effectiveness of detergent and soap solutions in different types of water
- explaining how water softeners react with minerals in water
- correctly determining if/how much water softener was needed
- supporting conclusions with data

5. Why Is It Difficult to Wash with Hard Water?

TEACHER RESOURCE PAGE



RECOMMENDED INTERNET SITES

- **Hardwater.org**
www.hardwater.org
- **U.S. Environmental Protection Agency—Office of Water**
www.epa.gov/ow
- **Water Pollution Guide**
www.water-pollution.org.uk



ANSWER KEY

1. Distilled water has little or no dissolved minerals in it. Tap water usually has trace amounts of minerals in it, and hard water has a large amount of dissolved minerals that lessen the sudsing ability of detergents and soap.
2. Water softeners combine with or replace the dissolved minerals so that detergents can perform correctly.
3. Answers will vary, but may include looking for signs of mineral deposits around faucets or in sinks, as well as observing the effectiveness of soap and/or detergent.

5. Why Is It Difficult to Wash with Hard Water?

STUDENT ACTIVITY PAGE



OBJECTIVE

To understand how dissolved solids change the properties of water

BEFORE YOU BEGIN

Most people use soap and water to wash their hands every day. The common solid soaps or liquid detergents are soluble in most tap water. However, not all water can be used with these soluble soaps. For example, some water contains dissolved mineral **ions** of either calcium or magnesium. These ions can combine with and inactivate the common soaps or detergents. This water is referred to as **hard water**. Soft water contains few, if any, dissolved minerals. It is recommended for use with soaps or detergents. It is, however, possible to make hard water usable for washing by adding a substance called a **water softener**. Water softeners combine with and remove the mineral ions that make water hard.

In this activity, you will work in groups to observe the ability of a common liquid detergent to form soapsuds with different samples of water. You will also use a water softener to treat a sample of hard water. You will then observe the suds-forming ability of this treated water.



MATERIALS

- medicine droppers
- ten 25-ml test tubes
- test-tube rack
- distilled water
- hard water
- tap water
- 1% soap solution
- 1% detergent solution
- water softeners (two different brands)
- crayon pencil
- 50-ml graduated cylinder
- two 100-ml beakers
- stopwatch, watch, clock, or other timing device



PROCEDURE

Part 1

1. Label six test tubes: two *tap water*, two *distilled water*, and two *hard water*.
2. Put 10 ml of each type of water in their respective test tubes.
3. Put 25 ml of a 1% soap solution in one 100-ml beaker.
4. Put 25 ml of a 1% detergent solution in another 100-ml beaker.
5. Using a medicine dropper, add 5 drops of soap solution to a test tube containing tap water.
6. One group member should cover the mouth of the test tube with a thumb and shake the test tube vigorously to create soap suds. Another group member should time how long the suds last.

5. Why Is It Difficult to Wash with Hard Water?

STUDENT ACTIVITY PAGE

7. If suds do not form, or form but do not last 1 minute, repeat using 5 more drops of soap and shake until the suds last for 1 minute.
8. Record the final number of drops of soap you used in the first data table in the Data Collection and Analysis section.
9. Repeat steps 5 through 8 using distilled water instead of tap water. Record how many drops of soap solution you used.
10. Repeat steps 5 through 8 using hard water. Record how many drops of soap solution you used.
11. Repeat steps 5 through 8 for each type of water, but this time add drops of the detergent solution instead of soap. Record how many drops of detergent solution you used.

Part 2

1. Label four test tubes: two for each brand of water softener (*Brand 1*, *Brand 2*).
2. Put 10 ml of hard water into each of the labeled test tubes.
3. Drop 10 grains of Brand 1 into both of the test tubes labeled *Brand 1*.
4. Hold a thumb over the mouth of each tube and shake to dissolve the water softener.
5. Drop 10 grains of Brand 2 into the other two test tubes.
6. Again, cover the mouth of each tube with a thumb and shake to dissolve the water softener.
7. Using a medicine dropper, add 5 drops of the soap solution to a tube labeled *Brand 1*.
8. One group member should cover the mouth of the test tube and shake vigorously. Another group member should keep track of how long the suds last. If suds do not form or do not last for 1 minute, add 5 more drops of soap solution and shake.
9. Repeat until the suds remain for 1 minute. Record the number of soap drops used in the second data table in the Data Collection and Analysis section.
10. Add 5 drops of the soap solution to a tube labeled *Brand 2*.
11. Repeat steps 8 and 9. Record your observations.
12. Add 5 drops of the detergent solution to a tube labeled *Brand 1*.
13. Repeat steps 8 and 9. Record your observations.
14. Add 5 drops of the detergent solution to a tube labeled *Brand 2*.
15. Repeat steps 8 and 9. Record your observations.



EXTENSION OPTION

Find a sample of water that will not form suds when shaken. Add a small amount of borax to the water and try to get it to form suds again. What action does the borax perform?

5. Why Is It Difficult to Wash with Hard Water?

STUDENT ACTIVITY PAGE



DATA COLLECTION AND ANALYSIS

Part 1

Solution	Number of drops of soap solution	Number of drops of detergent solution
Tap water		
Distilled water		
Hard water		

Part 2

Solution	Number of drops of soap solution	Number of drops of detergent solution
Hard water with Brand 1 softener		
Hard water with Brand 2 softener		

1. Which water sample needed the greatest amount of soap or detergent solution to make suds?

2. How effective was each type of water softener in obtaining suds with the soap solution? With the detergent solution?



CONCLUDING QUESTIONS

1. What are the differences among distilled water, tap water, and hard water?

5. Why Is It Difficult to Wash with Hard Water?

STUDENT ACTIVITY PAGE

2. What do water softeners do to hard water?

3. How would you determine if water is hard or soft?



FOLLOW-UP ACTIVITIES

1. Obtain water samples from different areas in your city or state. Repeat the tests performed in Part 1 of this activity. Create a water hardness chart, listing the different water samples and their origins.
2. Search the Internet to find other methods of water softening that are commercially available.