Water Hardness

When water passes through or over mineral deposits such as limestone, the levels of certain ions present in the water increase greatly and cause the water to be classified as hard water. This term results from the fact that calcium or magnesium ions in water combine with soap molecules. This forms a sticky scum that interferes with soap action and makes it “hard” to get suds. Soft water, such as rainwater or melted snow, is mostly free of these ions. Soft water, when mixed with soap will form suds. A Conductivity Probe can be used to test for ions in water. Hard water, because of the ions it contains, gives a high conductivity reading. Soft water gives a low conductivity reading.

In Part I of this experiment, you will learn how to test water hardness and find the hardness of the tap water in your school. In Part II, you will plan and conduct a water hardness study.

OBJECTIVES

In this experiment, you will

• Use soap to find water hardness.
• Use a Conductivity Probe to find water hardness.
• Determine the hardness of the water in your school.
• Apply what you have learned as you conduct a water hardness study.

MATERIALS

- computer
- LEGO NXT Intelligent Brick
- MINDSTORMS Edu NXT v2.0 software
- Vernier NXT Sensor Adapter
- Vernier Conductivity Probe
- NXT cable
- 25 mL graduated cylinder
- distilled water
- very hard water
- tap water
- 3 test tubes
- test tube rack
- Ivory liquid soap
- dropper
- ruler
- ring stand and utility clamp
- three 100 mL beakers
- wash bottle with distilled water
- waste cup

Figure 1
PROCEDURE

Part IA Soap Sudsing Tests
1. Place 10 mL of distilled water in one test tube. Place 10 mL of very hard water in a second test tube. Place 10 mL of tap water in a third test tube.
2. Add one drop of Ivory \textsuperscript{®} liquid soap to each test tube and insert the stoppers. Shake each test tube the same number of times.
3. Use a ruler to measure the suds height (in cm) in each test tube. Record the results in your data table.

Part IB Conductivity Tests
4. Fill a clean beaker halfway with distilled water. Fill a second beaker halfway with very hard water, and the third beaker halfway with tap water.
5. Connect the sensor and the NXT.
   a. Connect the Conductivity Probe to the Vernier NXT Sensor Adapter. The switch on the Conductivity Probe should be on the 0–2000 µS/cm setting.
   b. Connect the Adapter to Port 1 on the NXT using a LEGO NXT cable.
   c. Make sure the NXT is connected to the computer (USB or Bluetooth) and turned on.
7. Prepare the program for conductivity data collection.
   a. Click the Go button next to Start New Program.
   b. Drag a Vernier Sensor Block from the Sensor palette to the programming area.
   c. In the configuration panel at the lower-left side of the computer screen, select Conductivity Probe from the Sensor pull-down list.
   d. You should see live sensor readings displayed in the configuration panel. If the sensor reading is gray and not changing, the NXT is not communicating with the computer. Click on the NXT Window button at the top-left corner of the NXT Controller. If the NXT is not listed as Connected, you may need to check the power and connections and then select your NXT from the list presented. Once it is listed as Available, you can choose Connect.
8. Measure the conductivity for each of the three water samples.
   a. Use a wash bottle filled with distilled water to thoroughly rinse the Conductivity Probe as shown by your teacher.
   b. Lower the Conductivity Probe into the water sample until the hole in the probe end is completely submerged. Swirl the water around the probe briefly. Be careful not to damage the probe.
   c. Note the conductivity reading in the digital display. When the reading stabilizes, record the conductivity value in your data table.

Part II A Water Hardness Study
9. Use the skills you gained in Part I and do a study of water available in your community. You might compare surface water (from streams and ponds) with groundwater (from wells and springs). A study of the different bottled waters sold at local stores can also be done. Explain the hardness of the waters you test.
DATA AND OBSERVATIONS

<table>
<thead>
<tr>
<th></th>
<th>Suds height (cm)</th>
<th>Conductivity (µS/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distilled water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very hard water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tap water</td>
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</tbody>
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PROCESSING THE DATA

1. Is the tap water hard? Explain how you decided on your answer.

2. Where does your tap water come from? How does that source affect the hardness of the water?

3. How did the hardesses of the waters you tested in Part II compare?

4. Why is each of the waters you tested in Part II as hard (soft) as it is?

EXTENSIONS

1. Study the effectiveness of different water softeners.
2. Study the hardness of tap water at various places in your community.
Experiment 11

3. Compare the hardness of hot tap water with the hardness of cold tap water.

4. Do library research to get more information on what makes water hard.
Vernier Lab Safety Instructions Disclaimer

THIS IS AN EVALUATION COPY OF THE VERNIER STUDENT LAB.

This copy does not include:

- Safety information
- Essential instructor background information
- Directions for preparing solutions
- Important tips for successfully doing these labs

The complete STEM with Vernier and LEGO® MINDSTORMS® NXT lab manual includes 14 lab activities and four projects as well as essential teacher information. The full lab book is available for purchase at: http://www.vernier.com/cmat/stem.html

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