

# Penn State RET in Interdisciplinary Materials

## Teacher's Preparatory Guide

By John Bricker, Franklin Towne Charter High School

### ***Hard vs. Soft Water – What comes out of our faucet?***

**Purpose:** This lab is designed to help students understand the difference between hard and soft water; specifically, the ions that are (or are not) present in each. This lab is also intended to highlight zeolites, a practical example from the field of chemical engineering used in everyday life.

**Objectives:** SWBAT describe the difference between hard and soft water.  
SWBAT describe why the use of zeolites in detergent is beneficial.  
SWBAT identify the type of water that comes out of their faucet.

**Time required:** 1 period (50 minutes)

**Level:** High school (Physical Science, 9<sup>th</sup> grade)

#### **National Science Education Standards Levels, 9-12**

Science as Inquiry Standards

- Abilities necessary to do scientific inquiry

Physical Science Standards

- Structure and properties of matter

**Teacher Background:** Hard water has more minerals than soft water. Typically, this is calcium and magnesium from it coming into contact with rocks or soil. Soft water lacks those minerals but has sodium and potassium. These, sodium and potassium, are added to remove calcium and magnesium. Most people believe that hard water tastes better (ex. mineral water, Pan Pellegrino). Soft water lacks the minerals that bind with soap to rinse it away. Bathing with hard water leaves behind these minerals (soap scum, limescale).

#### **Materials**

- Six containers
- Distilled water
- Epsom salt
- Tap water
- Powdered laundry detergent
- Powdered soap

**Advance Preparation:** I recommend putting students into groups of 2-4. Make sure each group has access to all the materials.

**Safety Information:** Have students wear goggles.

**Teaching Strategies:** Give the students the background on hard/soft water. Ideally, this would be covered after the students have an understanding of ionic compounds in water. Give them some background on zeolites and explain that it acts as a sponge in that it can “soak up” ions.

**Resources:** This lesson plan comes from an already established lab from the Zhang group. All creative credit goes to Dr. Xueyi Zhang – I simply repurposed it for classroom use. The lab was used to show how one of their primary materials, zeolites, is present in an everyday material like detergent in a video series.

Name: \_\_\_\_\_

Points (out of 20): \_\_\_\_\_ Grade: \_\_\_\_\_

### Hard vs. Soft Water Lab – What comes out of our faucet?

**Background** (read this now and refer back to during your post-lab questions!):

- Hard water has ions like calcium and magnesium in it.
- Soft water has sodium and potassium (small amounts ideally).
- Soft water lacks the ions that bind with soap to rinse it away.
- Bathing with hard water leaves behind calcium and magnesium (ex. soap scum, limescale).
- Distilled water is purified water (only H<sub>2</sub>O, no ions).
- Epsom salt has magnesium sulfate in it.
- A zeolite is a material that can trap ions.
- Detergent is soap with a zeolite added.

**Materials:** Six containers, distilled water, Epsom salt, tap water, powdered laundry detergent, powdered soap

**Procedure:**

1. Label two of your containers “hard”, two as “soft”, and two as “tap”. In each pair, label one as “soap” and one as “detergent”.
2. Put 50 ml of distilled water into both containers labeled “distilled”. Then, put 50 ml of distilled water into both containers labeled “hard”. In the two containers labeled “hard”, put 20 g of Epsom salt to make the water “hard”.
3. Put 50 ml of tap water into both containers labeled “tap”.
4. In the containers labeled “soap”, add one “scoop” of the powdered soap. This does not need to be heaping. It should be a “level” scoop. Shake them up!
5. In the containers labeled “detergent”, add one “scoop” of the powdered detergent. This does not need to be heaping. It should be a “level” scoop. Shake them up!
6. Measure the height of your bubbles. Measure from the top of the liquid to the top of the bubbles. Record your data in the data table below. Make sure you are using units in the metric system!

**Data:**

	Soap	Detergent
“Hard” – Distilled + Epsom salt		
“Soft” – Distilled water		
Tap Water		

**Post-lab questions:**

1. Which condition produced the most bubbles? Why do you think this happened?
2. Why do you think a zeolite would be added to detergent?

- Is our tap water more like “hard” or “soft” water? Why do you think this?
- What ions might be present in our drinking water?

Name: \_\_\_\_\_

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**Data:**

	Soap	Detergent
“Hard” – Distilled + Epsom salt	Should be low	Should be high
“Soft” – Distilled water	Should be high	Should be high
Tap Water	Depends on your tap water!	Depends on your tap water!

**Post-lab questions:**

- Which condition produced the least bubbles? Why do you think this happened?  
Should be the “hard” water with soap.

2. Why do you think a zeolite would be added to detergent?  
To absorb the ions that prevent the soap from cleaning.
3. Is our tap water more like “hard” or “soft” water? Why do you think this?  
Answers vary
4. What ions might be present in our drinking water?  
Answer vary. Would be good to mention other “stuff” present in our water, like fluoride.