

**Lesson Plan: How Do We Know What is Healthy Water?**  
**pH /Chlorine / Hardness**

Estimated Time: 1-3 days

**State Standards taught and addressed – Grade 8:**

Standards Taught (and evaluated at end of lesson)

- Science Strand 3: Concept 1 PO 1. Analyze the risk factors associated with natural, human induced, and/or biological hazards, including: waste disposal of industrial chemicals
- Science Strand 5: Concept 1: Properties and Changes of Properties in Matter

*Standards addressed (could provide more detail if desired)*

- Science Strand 1: Inquiry Process
- Science Strand 2: C1 PO 4. Evaluate career opportunities related to life and physical sciences.
- Science Strand 2: Concept 2 Nature of Scientific Knowledge

**Vocabulary:**

<b>pH Activity</b>	<b>Chlorine Activity</b>	<b>Hardness Activity</b>
<ul style="list-style-type: none"><li>• Solution</li><li>• substance</li><li>• Acidic/Acid</li><li>• Basic/Alkaline</li><li>• neutral</li><li>• pH level</li><li>• limiting factors</li><li>• water quality</li><li>• ecosystem</li></ul>	<ul style="list-style-type: none"><li>• Chlorine</li><li>• Disinfectant</li><li>• chemical</li></ul>	<ul style="list-style-type: none"><li>• Hardness</li><li>• Calcium</li><li>• Magnesium</li><li>• Hard water</li></ul>

**Objectives:**

- Students will apply knowledge of pH, Chlorine, and Hardness related to water chemistry by conducting three experiments.
- Students will analyze results of their investigations to make generalizations about the impact of water quality on the environment during small group and class discussions.

## Lesson Supply List:

- litmus paper (4 – 6 pieces)
- (5) small solo cups.
- lemon juice
- Ammonia
- Vinegar
- Water
- Baking soda (mix with water)
- Aspirin (crush and mix with water)
- Pool kit capable of testing for pH, chlorine
- prepared water samples:
  - To prepare “acidic samples, add lemon juice or vinegar to the water samples.
  - To prepare “basic” samples, add baking soda or ammonia
- Water samples collected from various locations, areas. Some examples are as follows:
  - Drinking water
  - Pool water
  - Tap water
  - Pond water
  - Fish tank water

\*Note: For the chlorine test, you may want to make up a solution of water with a high level of chlorine using bleach and water so you get a good color reaction. The levels that you will probably find in the tap water or drinking fountain water may be relatively low. The recipe for “bleach-water” is 4 drops of bleach into one quart of water.

- Distilled water (available at most grocery stores)
- Epsom salt (magnesium sulfate)
- Baby food jars with lids (or other similar containers)
- Ruler
- Eyedropper
- Spoon
- Dishwashing liquid
- Lock or watch with a second hand or digitally displayed seconds

## **Background information:**

### ***Properties of Water:***

Water is essential for life on earth. Two-thirds of the earth's surface is covered with water, but most of this water cannot easily be used by humans. Of the earth's water, 97 percent is salt water. The remaining 3 percent is either frozen at the poles, found underground, or found on the surface of the earth. Only 1 percent of the earth's water is found in rivers, streams, lakes and marshes.

Water is sometimes called the universal solvent because so many different substances will dissolve in it. These substances are often salts, like sodium chloride, or organic molecules such as pesticides. Water in our environment is never found in completely pure form. Even rainwater contains dissolved gases and chemicals that affect its properties.

We study water and its properties to learn how to clean contaminated or polluted water, how to protect water from pollution, and how other substances and conditions affect water in the environment.

To understand environmental problems involving water, we need to understand more about water itself.

### ***pH:***

- pH is a measure of how acid or alkaline (basic) a solution or substance is. There is a scale used to measure acidity called the pH scale.
- This scale has numbers that range from 0 to 14. 7 on the pH scale represents a neutral pH (neither acidic or basic). Values less than 7 indicate acidity and values greater than 7 indicate alkalinity.
- There are many types of acids and bases that can produce different pH values such as lemon juice at pH 2.0, vinegar 2.2, milk 6.6, pure water 7.0, baking soda 8.2, and ammonia 12.0. Natural rainwater without pollutants is slightly acidic with a pH of about 5.6. The acidity of most healthy lakes is about 6.
- pH is important to water quality because the pH of the water determines what kinds of plants and animals can live there. Water that is too acidic or alkaline will kill the plants and animals. In a lake or pond, the water's pH is affected by its age and the chemicals discharged by communities and industries.

### ***Chlorine:***

- Chlorine is used as a disinfectant (a chemical that kills disease causing bacteria). It is commonly used to disinfect most drinking water supplies in the United States. In parts of the world where chlorine is not added to the drinking water, thousands of people get sick every year.
- Chlorine is also used as a disinfectant in wastewater treatment plants and swimming pools.
- It is widely used as a bleaching agent in many textile factories and paper mills and is an important ingredient in many laundry bleaches.

- Chlorine is toxic to fish and aquatic organisms. In high concentrations it can be toxic to humans also. However, only a small amount is needed to purify (disinfect) drinking water and most people can't detect the presence of chlorine in the water.

***Hardness:***

- Hardness is defined as the amount of calcium and magnesium present in water. The ability of water to remove soap is related to the hardness of the water. It is very difficult to get soap to lather in hard water and the white film you find on your shower door or inside your tea kettle is usually caused by hard water.

## **Procedures: pH**

### **pH Activity #1a:**

#### **Materials:**

- litmus paper (4 – 6 pieces)
- (5) small solo cups.
- lemon juice
- Ammonia
- Vinegar
- Water
- Baking soda (mix with water)
- Aspirin (crush and mix with water)

Note: other solid materials such as Alka-Seltzer, Roloids, powdered laundry detergent can also be used.

#### **Premise:**

Determine if various solutions are acidic or basic.

#### **Steps:**

1. Dispense a portion of each solution into paper cups
2. Test each one by dipping the litmus paper into the solution.
3. If the litmus paper turns red, the solution is acidic.
4. If the litmus paper turns blue, the solution is basic.

### **pH Activity #1b: Test the pH of various water samples**

#### **Materials:**

- pool kit capable of testing pH
- prepared water samples:
  - To prepare "acidic samples, add lemon juice or vinegar to the water samples.
  - To prepare "basic" samples, add baking soda or ammonia
- Field water samples: Students collect water samples from various locations. Examples such as:
  - Pools
  - Faucets
  - drinking fountains
  - ponds and/or retention basins
  - lakes or streams
  - fish tanks

#### **Steps:**

1. Fill test cell to the line with the water sample to be tested.
2. Add 5 drops of the pH solution to the test cell.
3. Place cover over the test cell and invert several times to mix.
4. Compare the color obtained during the reaction to the respective color standards.

**Discussion:**

Hold a class discussion about the results of the investigation. Allow students to record observations and conclusions in their lab notebook. Discuss why they think pH is related to water quality. Use the following discussing points to guide their learning.

- pH is a measure of how acid or alkaline (basic) a solution or substance is. There is a scale used to measure acidity called the pH scale.
- This scale has numbers that range from 0 to 14. 7 on the pH scale represents a neutral pH (neither acidic or basic). Values less than 7 indicate acidity and values greater than 7 indicate alkalinity.
- There are many types of acids and bases that can produce different pH values such as lemon juice at pH 2.0, vinegar 2.2, milk 6.6, pure water 7.0, baking soda 8.2, and ammonia 12.0. Natural rainwater without pollutants is slightly acidic with a pH of about 5.6. The acidity of most healthy lakes is about 6.
- pH is important to water quality because the pH of the water determines what kinds of plants and animals can live there. Water that is too acidic or alkaline will kill the plants and animals. In a lake or pond, the water's pH is affected by its age and the chemicals discharged by communities and industries.

**Making the Connection:**

Questions:

- Summarize what we learned about the pH scale.
- How do you think pH contributes to or indicates the quality of the water?
- How do you think water quality affects life in an ecosystem?
- What do you think would happen to an ecosystem if the pH suddenly shifted either more acidic or more basic?

Review new vocabulary:

- Solution
- substance
- Acidic/Acid
- Basic/Alkaline
- neutral
- pH level
- limiting factors
- water quality
- ecosystem

**Activity Closure:**

Allow students to share their new learning with a partner, or summarize three things they learned in their science notebook or lab journal.

## **Procedures: Chlorine**

### **Materials:**

- Pool kit capable of testing for chlorine
- Water samples collected from various locations, areas. Some examples are as follows:
  - Drinking water
  - Pool water
  - Tap water
  - Pond water
  - Fish tank water

\*Note: you may want to make up a solution of water with a high level of chlorine using bleach and water so you get a good color reaction. The levels that you will probably find in the tap water or drinking fountain water may be relatively low. The recipe for "bleach-water" is 4 drops of bleach into one quart of water.

### **Premise:**

Determine chlorine levels in various water samples.

### **Steps:**

1. Fill test cell to the line with the water sample to be tested.
2. Add 5 drops of the OTO solution to the test cell
3. Place cover over the test cell and invert several times to mix.
4. Compare the color obtained during the reaction to the respective color standards.

### **Discussion:**

Hold a class discussion about the results of the investigation. Allow students to record observations and conclusions in their lab notebook. Discuss why they think Chlorine is related to water quality. Use the following discussing points to guide their learning.

- Chlorine is used as a disinfectant (a chemical that kills disease causing bacteria). It is commonly used to disinfect most drinking water supplies in the United States. In parts of the world where chlorine is not added to the drinking water, thousands of people get sick every year.
- Chlorine is also used as a disinfectant in wastewater treatment plants and swimming pools.
- It is widely used as a bleaching agent in many textile factories and paper mills and is an important ingredient in many laundry bleaches.
- Chlorine is toxic to fish and aquatic organisms. In high concentrations it can be toxic to humans also. However, only a small amount is needed to purify (disinfect) drinking water and most people can't detect the presence of chlorine in the water.

**Making the Connection:**

Questions:

- Summarize what we learned about Chlorine.
- How do you think the chlorine level contributes to or indicates the quality of the water?
- Should chlorine be in natural water sources such as rivers and lakes?
- What do you think would happen to a natural ecosystem if the chlorine levels were too high?

Review new vocabulary:

- Chlorine
- Disinfectant
- chemical

**Activity Closure:**

Allow students to share their new learning with a partner, or summarize three things they learned in their science notebook or lab journal.

## **Procedures: Hardness**

### **Materials:**

- Distilled water (available at most grocery stores)
- Epsom salt (magnesium sulfate)
- Baby food jars with lids (or other similar containers)
- Ruler
- Eyedropper
- Spoon
- Dishwashing liquid
- Lock or watch with a second hand or digitally displayed seconds

### **Premise:**

Demonstrate the effects of hard water on soap suds.

### **Steps:**

1. Fill each of two jars with  $\frac{1}{4}$  cup of distilled water.
2. Label one jar with an "S" for soft and the other with an "H" for hard.
3. Add  $\frac{1}{4}$  teaspoon of Epsom salt to the jar labeled "H". Allow the salt to completely dissolve.
4. Add one drop of dishwashing liquid to each of the jars.
5. Tighten the lids and shake both jars for 30 seconds.
6. Allow both jars to stand for 15 seconds.
7. Use the ruler to measure the height of the suds above the water level. Record results.

### **Discussion:**

Hold a class discussion about the results of the investigation. Allow students to record observations and conclusions in their lab notebook. Discuss why they think hardness is related to water quality. Use the following discussing points to guide their learning.

- Hardness is defined as the amount of calcium and magnesium present in water. The ability of water to remove soap is related to the hardness of the water. It is very difficult to get soap to lather in hard water and the white film you find on your shower door or inside your tea kettle is usually caused by hard water.
- The preceding activity can be used to demonstrate the effects of hard water on soap suds. It compares the height of suds in two jars, one containing soft and the other hard water. The question to be answered is "Which type of water yields the higher suds?"

### **Making the Connection:**

Questions:

- Summarize what we learned about hardness.

- How do you think the hardness level contributes to or indicates the quality of the water?
- What levels of calcium and magnesium do you think are present in natural/raw water (before being treated)?
- What do you think would happen to a natural ecosystem if the hardness levels were too high? Too low?

Review new vocabulary:

- Hardness
- Calcium
- Magnesium
- Hard water

### **Activity Closure:**

Allow students to share their new learning with a partner, or summarize three things they learned in their science notebook or lab journal.

### **Lesson Extensions:**

Literacy Connection: Have students research the limiting factors of certain organisms in an ecosystem – specifically related to water quality and pH, chlorine, and hardness.