



Watershed Warriors: Atomic Structure and pH Lesson Plan

Stage One: Desired Results

1. Essential Question(s):
 - What is the structure of a water molecule?
 - What changes occur within the structure of the water when the pH changes?
 - How does pH impact marine organisms and the surrounding environment?
 - How can humans impact pH?
2. Mastery Objective(s): *SWBAT*:
 - 1) 5.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
 - d) hypotheses are formed from testable questions;
 - e) independent and dependent variables are identified;
 - f) constants in an experimental situation are identified;
 - g) data are collected, recorded, analyzed, and communicated using proper graphical representations and metric measurements;
 - i) inferences are made and conclusions are drawn;
 - j) models are constructed to clarify explanations, demonstrate relationships, and solve needs; and
 - k) current applications are used to reinforce science concepts.
 - 2) 5.4 The student will investigate and understand that matter is anything that has mass and takes up space; and occurs as a solid, liquid, or gas. Key concepts include
 - c) atoms and elements;
 - d) molecules and compounds; and
 - e) mixtures including solutions.

Stage Two: Assessment Evidence

1. Summative Assessment:
 - A lab in which students will first make play-dough models of the hydrogen and oxygen atoms and then put them together to make a water molecule. Then they will hypothesize whether three liquids, water, vinegar, and baking soda, are acidic basic or neutral. Then they will test these three liquids to see whether their hypothesis were correct.

Stage Three: Learning Plan

- Materials
 - Homemade Play-doh in three different colors (e.g. purple, green, and orange; enough to give each student in the class about a 1 in ball of each color)
 - Watershed Warriors Atomic Structure and pH lab sheet
 - Hydrogen and Oxygen periodic table element printouts

- o Water bottles: (3 per group; the number of groups in the class depends on the class)
 - In one, mix as much baking soda as will dissolve/mix evenly with the water (to create an alkaline solution)
 - In the second, mix 1-3 tbsps of vinegar (to create an acidic solution)
 - Leave the third as water (to create a neutral solution)
- o pH test paper (indicator tablets or other methods of measuring pH can be used as well)
- o 2x4 in pieces of wax paper or parchment paper (1 per student; optional - makes constructing the atom models and using the templates easier)
- Warm up/Discussion:
 - o Watch Bill Nye video on atoms and water
<https://www.youtube.com/watch?v=nB6ZiPguUW0>. Atoms 4:09-5:12, Water Molecule, 9:05-10:37.
 - o Watch video on impact of pH on fish in Appalachian Mountains:
<http://channel.nationalgeographic.com/videos/acid-rain-invisible-menace/>
 - o Backup pH video: <https://www.youtube.com/watch?v=Ms4v0Ekvyuw>. pH in stream 0:00-2:10
- Activator Activity
 - o Discuss what the students saw in the videos, starting with a review of the different parts of an atom. Talk about the structure of the atom and the placement of the electrons, protons, and neutrons.
 - o Review the water molecule. What elements make up water, and how many atoms of each does it contain? (H₂O)
 - o Introduce the concept of pH. Talk about how sometimes the number of protons and electrons in water aren't even and how this can impact aquatic organisms. Reference the videos on pH.
- Simulation: Modeling the atomic structure of pH with play-doh. This lab can be done with the entire class at once or in smaller groups. The student-teachers can decide which structure to use depending on the class. (A combination of the two can also be used.)
 - o Pass out the lab sheets and a 1 in ball of each color of play-doh to each student.
 - o Hold up the periodic table printouts for oxygen and hydrogen. Walk them through how to use the atomic number and the atomic mass to calculate the number of protons, electrons, and neutrons in each atom of that element.
 - o Once the students have recorded the number of particles in each atom, have them construct each type of atom using the play-doh and the template on their lab sheet. Each color of play-doh should be used for a different type of particle. If using wax paper or parchment paper, have the students place the paper over the template and then construct their atoms. Have them count the number of protons and electrons and record it on their lab sheets.
 - o Ask the students what atoms make up a water molecule. Have them construct another hydrogen atom and then lead them through combining

the atoms to make a water molecule. Talk about how the hydrogen atoms and oxygen atom share electrons in order to stay together. After each step, have them count the number of protons and electrons and record it on their lab sheets.

- o Have them simulate adding an acid to the water by adding another proton. Acids have a higher concentration of hydrogen ions (protons) and can contribute these protons to the water, causing it to become more acidic. A good metaphor to help illustrate this for the student is that the acid is “generous” and gives away protons. Have them count the number of protons and electrons and record it on their lab sheets.
- o Have them remove the extra proton. Now simulate adding a base to the water by taking away a proton. Bases have a lower concentration of hydrogen ions (protons) and can accept protons from the water, causing it to become more basic. A good metaphor to help illustrate this for the student is that the base is “greedy” and steals protons from the water. Have them count the number of protons and electrons and record it on their lab sheets.
- o Talk to the students about the number of protons and electrons at each step. When were they balanced? When were there more protons? When were there more electrons? What do they think is the ideal number of protons and electrons and why?
- Lab: Demonstrate pH of household materials.
 - o Now that the students understand pH, it is time to demonstrate it using household items such as water, baking soda, and vinegar. In the table on the lab sheet, have the students hypothesize which solutions will be acidic, which will be neutral, and which will be basic.
 - o Once they have drawn the hypothesis, ask for a student volunteer to come to the front and test dip the pH paper in the Vinegar solution. Pull the paper out and watch for a change in color. Help the students determine the pH of the solution using the color key. Have the students write down their observations in the table.
 - o Repeat the previous step with the pure water and the baking soda solutions.
 - o Once the experiment is complete, have them place each solution on the pH scale and draw conclusions about the balance of protons and electrons in each solution.
- Summary/conclusion discussion.
 - o Review the connection between atomic structure and pH, including the balance of protons and electrons in acids and bases and in each solution in the lab. Talk about how pH can impact marine organisms and why it is important that pH of water remain neutral.