Lesson Title	pH, Do We Have Anything In Common? Love, Electrical Current
Length of Lesson	90 minutes
Created By	Erin Anderson
Subject	Chemistry
Grade Level	9-12
State Standards	1F, 1G, 3B, 3C, 13A, 13E
DOK Level	3-4
DOK Application	Investigate, Explain phenomena in terms of context, Connect
National Standards	B. Physical Science
Graduate Research Element	Ions undergo oxidation/reduction reactions all the time in the water column and sediment porewater of water bodies. These reactions control the pH and conductivity (ability to transmit electrical current) of the water column and porewater, which often affects the quality of animal life within bays. Pyritization will occur in very reduced porewater, where sulfide and reduced iron react to form precursor minerals to pyrite.

Student Learning Goal: pH and electrical current appear to have nothing in common…or do they? Electron transfer between ions is known as electrical current, and concentrations of hydrogen and hydroxide ions control the pH of liquids. Basically, ions control the world!

State Standards: 1F. Relate symbols to names of common chemical elements. 1G. Write the symbol or formula of monatomic and polyatomic ions. 3B. Identify the three fundamental particles of an atom when given the charge, mass, and location of the particle. 3C. Determine the number of protons, electrons or neutrons in an element when given the atomic number and the atomic mass of the element, or vice versa. 13A. Compare properties of acids and bases, including how they affect indicators and the relative pH of the solution. 13E. Describe the role of indicators in experimental prediction of pH.

National Standards: B. Physical Science: Matter is made of minute particles called atoms, and atoms are composed of smaller components. These components have measurable properties, such as mass and electrical charge. Atoms interact with one another by transferring or sharing electrons that are furthest from the nucleus. A large number of important reactions involve the transfer of either electrons (oxidation/reduction reactions) or hydrogen ions (acid/base reactions between reacting ions, molecules or atoms. The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel. The strength of the force is proportional to the

charges, and as with gravitation, inversely proportional to the square of the distance between them. Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces.

Materials Needed (supplies, hand-outs, resources): Baking soda, grape juice, sponge brushes, card stock, Q-tips, 20 lemons, 20 pickles, 20 potatoes, 5 volt meters, 5 sets of volt meter clamps, pennies, galvanized nails, 10 plastic knives (for incision into fruits and veggies for pennies), HCl, limestone, and rocks other than limestone, blender, red cabbage leaves, water, strainer, (5) 100 ml graduated cylinder, (1) 1 liter beaker, sprite, apple juice, bleach, shampoo (clear, non-colored), baking soda, 20 small plastic cups.

Lesson Performance Task/Assessment:

(1) Students will construct 3 batteries from a lemon, a pickle and a potato. They will record the voltage differences each battery produces.
(2) As an introduction into the next part of the lesson, I will demonstrate the strength of acids by fizzing a piece of limestone: active chemical erosion that students can see! Will mention relationship to research: ions control pH, oxygen availability and the quality of life for animals living within bays.
(3) For the final part of the lesson, the students will help me make a pH indicator from red cabbage leaves. We will blend several cabbage leaves in 800 ml of water. Next, we will strain the leaf particles from the liquid with a strainer. The liquid will go into a 1 L beaker. The liquid will be divided among the students, and they will add 50 ml of red cabbage juice to their cup of either: sprite, apple juice, bleach, shampoo, baking soda-water mixture. Each group will present their results to the rest of the class.

Lesson Relevance to Performance Task and Students:
After each experiment, I will explain how ions played a role in each activity. For the anticipatory set, I will explain about adding an acid to their message, which was written with a basic solution. The hydroxide ions were bonded with the hydrogen ions when grape juice was adding, causing their secret messages to reveal. For the batteries, negatively charged ions release their outer electrons to positively charged ions, creating a flow of electrons (also known as electricity). Acidic pH solutions are dominated by hydrogen ions, and basic pH solutions are dominated by hydroxide ions.
I will stress that ions are a good thing—we cannot live without ions!

Anticipatory Set/Capture Interest: Each student will be given a cup of equal parts baking soda and water mixture, card stock, and Q-tips. The students will mix their solutions and use Q-tips to draw masterpieces or write secret messages. The messages will be revealed at the end of the lesson.

Guided Practice: During their pH presentations, the students will explain why they think certain household products have a specific pH. They will be told that they must include ions in their reasoning.
Independent Practice: Students will use their newly-created pH indicator liquid to determine the pH of different household liquids. They will present their findings to the class.
Remediation and/or Enrichment: All IEP's will be supported. For remediation, I will be available for questions. I will help students construct their batteries and add their pH indicator solutions. For enrichment, I will discuss how ions are important in the human body for muscle contraction and relaxation, communication between the brain and the rest of the body.

Check(s) for Understanding: During the group presentations, I will ask questions concerning ions and pH readings and electricity.
Closure: Students will reveal their hidden paintings and masterpieces.
Possible Alternate Subject Integrations: Physics, Earth Science
Teacher Notes:

Red Cabbage pH Indicator Colors
Color: Pink (1-2 pH) Dark Red (2-4 pH) Violet (5-7 pH) Blue (8 pH) Blue-Green (9-10 pH) Green-Yellow (11-12 pH)

Title of Lab: It's a good Indicator. Chemistry Matters. 2003 Aims Education Foundation. P. 165-171; 173.