

Electrolysis of Water

Student Objective

The student:

- will be able to explain how hydrogen can be extracted from water
- will be able to explain how energy flows through the electrolysis system

Key Words:

compound
electrolysis
hydrogen
molecule
oxygen

Materials:

- photovoltaic cell (3V min) or 9-volt battery (1 per group)
- piece of aluminum foil, approx. 6 cm x 10 cm (2 per group)
- salt
- electrical wires with alligator clips (2 per group)
- beaker or small bowl (1 per group)
- water
- stirring rod or spoon
- graduated cylinder (several per class)
- Science Journal

Time:

1 hour

Background Information

When you add salt to the water, the salt ions (which are highly polar) help pull the water molecules apart into ions. Each part of the water molecule (H₂O) has a charge. The OH⁻ ion is negative, and the H⁺ ion is positive. This solution in water forms an electrolyte, allowing current to flow when a voltage is applied. The H⁺ ions, called cations, move toward the cathode (negative electrode), and the OH⁻ ions, called anions, move toward the anode (positive electrode). Bubbles of oxygen gas (O₂) form at the anode, and bubbles of hydrogen gas (H₂) form at the cathode. The bubbles are easily seen. Twice as much hydrogen gas is produced as oxygen gas. The net reaction:



Procedure (prior to class)

1. Make up one set of experimental apparatus that the students may use as a model during their experiments.

Procedure (during class)

1. Read the following passage to the students (This passage also appears on the student's science journal):

Electrolysis is a technique used by scientists to separate a compound or molecule into its component parts. By adding electricity to water and providing a path for the different particles to follow, the water can be separated into hydrogen and oxygen.

In this experiment you will be taking a sample of salt water and add a flow of electricity to it (the electrolysis). You will see the hydrogen and oxygen bubbling up.

2. Divide the students into lab groups of 3 - 4 students per group.
Give the students an overview of what they will be doing. Then break it down into smaller steps, explain each procedure and have the groups work simultaneously. The students will:
 - Accordion-fold each piece of aluminum foil down the long way so that you have two pieces approximately 1 cm x 6 cm. These are going to be your electrodes
 - Press each electrode flat
 - Bend the top 1 cm of each electrode over to act as a hanger
 - Dissolve salt into water at the ratio of one teaspoon salt for each 50 ml of water. Stir to dissolve the salt
 - Hang the electrodes on the inside of the bowl so that they hang down into the water. They should hang a couple inches apart--do not let them touch during the experiment. Add more salt water if necessary
 - Attach one end of each wire to the hanger of your electrode
 - Attach the other end of each wire to your photovoltaic panel or a battery. Make a note which electrode is attached to the positive and which is attached to the negative terminal of your battery
 - If using photovoltaics, take your electrolysis device outside into the Sun.
3. Assist students as needed during the experiment.
4. Lead a discussion on the student's observations and the significance of their observation. Points to cover may include:
 - The process that they observed was the breaking apart of the molecules of water (by using electrical energy) into its parts: hydrogen and oxygen
 - The chemical formula for water is H_2O (students may have heard this previously and not understood what it meant). Explain that it means that water is a molecule that is a combination of hydrogen and oxygen. The two means that there are two atoms of hydrogen to every atom of oxygen
 - The hydrogen and oxygen produced were gases. (Can water be a gas also? How?)
 - The process that they observed could be reversed. Oxygen and hydrogen can be combined to produce water and electricity. The apparatus used to do this is called a fuel cell.
 - Hydrogen is used as a combustible fuel on the Space Shuttle, and can also be used to make electricity with a fuel cell.
5. Students should complete the questions in their Science Journal

Further Research

1. How does varying the concentration of the salt water affect the number of bubbles produced by the electric current?
2. How does varying the amount of electricity in the hydrolysis circuit affect the amount of gas being produced?
3. How could you capture and measure the amount of gas produced?
4. Where is hydrogen currently being used in the state of Florida? How much is used per year? Where is it produced?

Related Reading

- ***Hydrogen Power of the Future: New Ways of Turning Fuel Cells into Energy*** by Chris Hayhurst (Rosen Publishing, 2003)
This book discusses the pros and cons of using hydrogen power to help fight air pollution and meet our growing demand for electricity.
- ***The Story of Hydrogen*** by Mark Uehling and Frank Watts (Franklin Watts, 1995)
Discusses the discovery, nature, behavior, and uses of the element hydrogen.
- ***Henry Cavendish & The Discovery of Hydrogen*** by Josepha Sherman (Mitchell Lane Publishers, 2005)
The strange little man was unnaturally shy. He couldn't stand looking anyone in the face. He was unable to bear meeting more than one person at a time, and ran away if too many people came near him. When he had to go out, he sat in the shadows of his carriage so that no one could see him. He wore the same old-fashioned outfit day after day. And he never, ever spoke to a woman. And yet Henry Cavendish was also a brilliant man who made one of the most important discoveries of the nineteenth century—hydrogen, among other things.

Internet Sites

http://www.gm.com/company/gmability/edu_k-12/5-8/games/more.html

General Motors. Fuel cell games—a matching game, sliding puzzle and crossword.

<http://library.thinkquest.org/11430/experimental/electrolysis.htm>

Thinkquest. Animation of water electrolysis. Lets you reverse polarity and test each gas with a splint.

High-energy Hydrogen I Florida Sunshine State Standards Benchmarks/Grade Level Expectations

Electrolysis of Water

			.1	.2	.3	.4	.5	.6
Nature of Matter	Standard 1	SC.A.1.2-				X	X	
	Standard 2	SC.A.2.2-	X					
Energy	Standard 1	SC.B.1.2-	X			X		
	Standard 2	SC.B.2.2-						

Benchmark SC.A.1.2.4 - The student knows that different materials are made by physically combining substances and that different objects can be made by combining different materials.

Grade Level Expectations

The student:

Fifth

- knows that different materials can be physically combined to produce different substances.

Benchmark SC.A.1.2.5 - The student knows that materials made by chemically combining two or more substances may have properties that differ from the original materials.

Grade Level Expectations

The student:

Fifth

- knows that materials made by chemically combining two or more substances have properties that differ from the original materials.

Benchmark SC.A.2.2.1 - The student knows that materials may be made of parts too small to be seen without magnification.

Grade Level Expectations

The student:

Fifth

- knows that materials may be made of parts too small to be seen without magnification.

Benchmark SC.B.1.2.1 - The student knows how to trace the flow of energy in a system.

Grade Level Expectations

The student:

Fourth

- knows how to trace the flow of energy in a system

Fifth

- knows how to trace the flow of energy in a system.

Benchmark SC.B.1.2.4 -The student knows the many ways in which energy can be transformed from one type to another.

Grade Level Expectations

The student:

Fourth

- knows ways that energy can be transformed.

Electrolysis of Water

compound - composed of two or more substances, ingredients, elements, or parts

electrolysis - chemical change, especially decomposition, produced in an electrolyte by an electric current

hydrogen - a colorless, highly flammable gaseous element, the lightest of all gases and the most abundant element in the universe

molecule - the smallest part of a substance that retains the chemical and physical properties of the substance and is composed of two or more atoms

oxygen - an element that at standard temperature and pressure is colorless, tasteless, and odorless (required for nearly all combustion and in the cellular functioning of animals)

Electrolysis of Water

Electrolysis is a technique used by scientists to separate a compound or molecule into its component parts. By adding electricity to water and providing a path for the different particles to follow, water can be separated into hydrogen and oxygen.

In this experiment you will be taking a sample of salt water and adding a flow of electricity to it (the electrolysis). You will see the hydrogen and oxygen bubbling up in this experiment.

1. What is it that you are trying to accomplish in this experiment?

2. Write a hypothesis of what you think might happen during your experiment.

Assemble your electrolysis apparatus and observe what happens.

3. What happened when the electric current was passed through the salt water?
