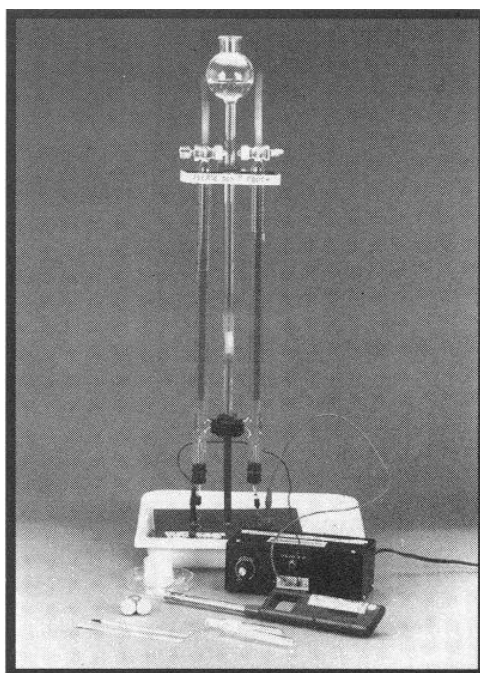




SIDE DISPLAY **Electrolysis**

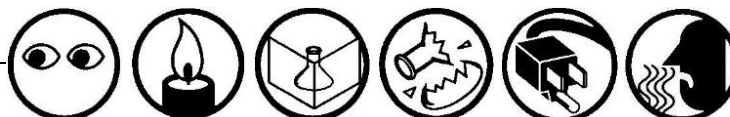
Visitors observe two glass tubes containing water. Electrodes are passing an electric current through the water. Oxygen gas is formed in the tube connected to the positive electrode. Hydrogen gas is produced in the tube connected to the negative electrode. The process produces twice as much hydrogen gas as oxygen gas. The hydrogen is collected in an upside-down test tube and put over a candle flame. A loud squeak results and the flame is blown out. The oxygen is collected in an upright test tube and a glowing splint inserted in the tube relights.



OBJECTIVES:

Visitors learn that electrolysis can break water down into its+ component elements. They observe that there is twice as much hydrogen in water as there is oxygen.

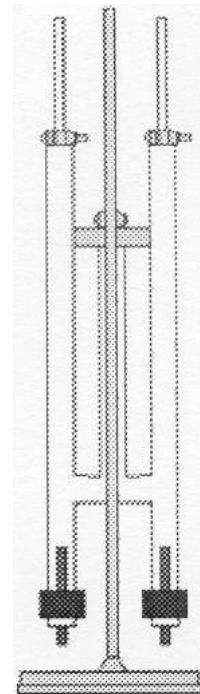
SCIENCE TOPICS	PROCESS SKILLS	VOCABULARY
Electrolysis	Observing	Atom
Electricity	Inferring	Gas
Properties of Molecules	Comparing/Contrasting	Molecule



Electrolysis

To do and notice:

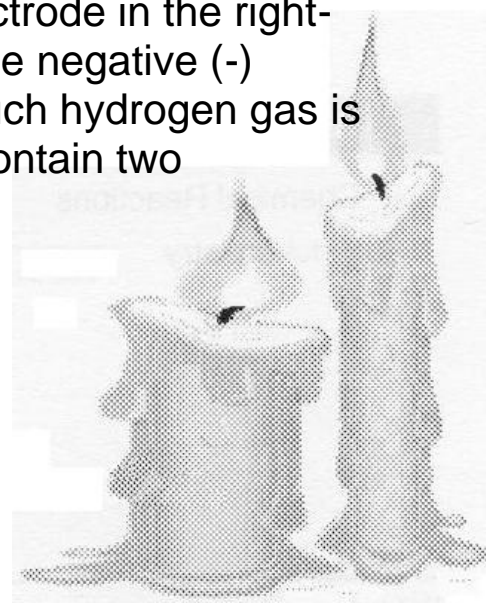
1. Look for the bubbles rising in the two glass tubes.
Is one side producing bubbles faster than the other side?
2. Compare the amount of liquid and gas in each tube.
Which tube has more gas?



What is going on?

The liquid in the glass tubes is water. At the bottom of the tubes, wires are sending an electric current through the water. The electricity causes the water molecules (H_2O) to split apart into hydrogen gas (H_2) and oxygen gas (O_2). This process is called electrolysis.

Oxygen gas is formed at the positive (+) electrode in the right-hand tube, and hydrogen gas is formed at the negative (-) electrode in the left-hand tube. Twice as much hydrogen gas is produced because water (H_2O) molecules contain two hydrogen atoms for each oxygen atom.



MATERIALS

See *Materials Prep*
for more details

(with amounts to have on hand)

- Hoffman electrolysis apparatus (WARDS Biology/lab Supplies, 1-800-962-2660)
- Bobbitt low-Voltage (12V DC) Power Supply (Carolina Science and Math, 1-800-227-1150)
- Concentrated H_2SO_4 (sulfuric acid) (keep 100 ml on hand)
- Two clean, dry, medium-sized test tubes
- 10-ml graduated cylinder
- 600-ml beaker
- Deionized water (dH_2O) (keep 500 ml on hand)
- Wooden splints
- Candle
- Butane lighter or matches

Setup/Takedown Procedures**ORIGINAL SETUP**

- Follow manufacturer guidelines for electrolysis setup.

WEEKLY SETUP

- Set a large Plexiglas shield around the apparatus so that visitors are less inclined to touch it.
- Place the electrolysis setup on the counter next to the protective eyewear .
- Carefully pour 2% H_2SO_4 (sulfuric acid) solution (see Materials Prep) into the center tube until both tubes are filled and the round bulb is $\frac{1}{4}$ full. (You will need to open valves until the liquid level reaches them.)

DAILY SETUP

- Turn on the low-voltage (12V DC) power supply.
- Wait until the gas level is at least the length of a test tube before testing the gases.
- Test both gases at the same time so that when the tubes are filling, the ratio of volumes in the two tubes is correct.
- Collect hydrogen gas with the test tube upside down over the valve. (Turn off the valve quickly, before the liquid starts coming out.)



- Keeping the test tube upside down, place it over the candle flame.
- You should hear a loud pop or squeak as the hydrogen combusts inside the test tube. The candle may also go out.
- Collect oxygen gas with the test tube right side up. (Turn off the valve before the liquid comes out.)
- A glowing splint inserted into the tube should catch on fire again. It may take a little practice to get the splint to stay lit. (You need to pull the splint out of the test tube before it consumes all the oxygen or it will go out again.)

DAILY TAKEDOWN

- Turn off the power supply at the end of the day.
- The solution in the tubing should last a week or more.

WEEKLY TAKEDOWN



- Carefully drain and rinse the apparatus several times. (Save and label the excess solution; it can be reused next time.)

CAUTION: the glass apparatus is very fragile and expensive—
PLEASE HANDLE GENTLY.



RUNNING SUGGESTIONS



- ◇ You will need to keep an eye on this display throughout the day.
- ◇ Release the gas before the solution in the center overflows.
- ◇ Ask visitors why one tube has twice as much gas as the other. (There is twice as much hydrogen because there are two hydrogens for every oxygen in water.)



EXTENSIONS

The water has a slight amount of acid in it — why is this necessary? (Pure water is a poor conductor of electricity; the acid is added to conduct the current and make the process more efficient. You can relate this to the Unit 1 “Just Charge It” experiment.)

Electrolysis can be used to separate other compounds, such as separating ammonia into nitrogen and hydrogen gas.

SAFETY & DISPOSAL

Sulfuric acid is a hazardous substance; follow handling and disposal instructions.

Consult Material Safety Data Sheets (MSDS) for additional information.

MATERIALS PREP

To prepare 2% H_2SO_4 (sulfuric acid) solution:



CAUTION: Concentrated sulfuric acid is extremely corrosive. Handle with care. Wear protective gloves, apron, and eyewear. Use only in the fume hood. Avoid contact with skin or clothing. Neutralize any spills with baking soda and clean with a large amount of water. CAUTION: A great amount of heat will be evolved after you mix H_2SO_4 with water. Do not handle beaker until it has cooled.

- Turn on the fume hood.
- Wear protective eyewear, chemical safety gloves, and apron or lab jacket.
- Fill beaker with 490 ml of dH_2O (deionized water) and place it in the fume hood.
- In the fume hood, carefully measure 10 ml of concentrated sulfuric acid (18M) into the graduated cylinder.
- Add the acid to the beaker of water.
- Store any extra solution in a labeled/dated bottle in acids cabinet.
- Turn off the fume hood.

