

# Electrochemistry - Electrolysis of Water

## OVERVIEW

During electrolysis, electrical energy is used to cause a nonspontaneous chemical reaction to occur. Electrolysis is often used to obtain elements that are too chemically reactive to be found free in nature. In this experiment electrolysis will be used to separate water into hydrogen gas and oxygen gas. During this experiment you will perform certain tests for the products of each of the half-reactions involved in the process.

Reduction will occur at the cathode. At this electrode hydrogen gas and hydroxide ions are formed. The electrons required for this reduction will come from the power source:  $4\text{H}_2\text{O} + 4\text{e}^- \rightarrow 2\text{H}_2 + 4\text{OH}^-$

Oxidation will occur at the anode, producing oxygen gas and hydrogen ions. The electrons that are produced will return to the power source:  $2\text{H}_2\text{O} \rightarrow \text{O}_2 + 4\text{H}^+ + 4\text{e}^-$

Adding the two half-reactions together gives us a net reaction of:  $6\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2 + 4\text{H}^+ + 4\text{OH}^-$

The  $\text{H}^+$  and  $\text{OH}^-$  that are produced will combine to form  $4\text{H}_2\text{O}$ :  $6\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2 + 4\text{H}_2\text{O}$

Finally we can simplify our overall equation to:  $2\text{H}_2\text{O}_{(l)} \rightarrow 2\text{H}_{2(g)} + \text{O}_{2(g)}$

## PURPOSE

- To use electrolysis to separate water into hydrogen and oxygen gas.

## SAFETY

- Small amounts of explosive hydrogen gas will be generated. Safety goggles should be worn when testing for the presence of hydrogen gas.

## EQUIPMENT AND MATERIALS

- pins
- well-plate
- pipets
- 2-half-straws
- 2 eraser caps
- 9V battery
- 1.0M sodium sulfate solution w/phenolphthalein
- Alligator clips

## PROCEDURE

1. Place a pin about 1/5 of the way up from the bottom of the straw. Place another pin at about the same location on the other half-straw.
2. Place the half-straw in the sodium solution containing phenolphthalein. Make sure the side with the pin is in the solution.
3. Place the eraser cap onto the top of the straw. Place each half straw into the same well. Keep the straw vertical as you may spill solution. Fill the well 2/3 of the way with sodium solution (use a pipet)
4. Attach a black alligator clip onto one pin and place it on the negative “-” terminal.
5. Attach a red alligator clip onto one pin and place it on the positive “+” terminal
6. Let it run! Write down any observations.

## CONCLUSIONS AND QUESTIONS

1. Write down any observations that you may have.
2. Why is salt solution needed? If pure water were used, what would you expect to occur?
3. Which straw (the one with more or less volume of gas) is the anode? Write the balanced half-reaction for the reaction occurring at the anode.
4. Which straw (the one with more or less volume of gas) is the cathode? Write the balanced half-reaction for the reaction occurring at the cathode.
5. Write the balanced net ionic equation for the electrolysis of water.
6. How could you tell which straw has oxygen gas and which straw has hydrogen gas?
7. How can you test for the presence of hydrogen and oxygen gas?