Carolina Quick Tips®

Petri Dish Electrolysis

This electrolysis of water on a microscale demonstrates a redox reaction (reduction-oxidation reaction). It also touches on the logistics and efficiency of hydrogen fuel production by means of water electrolysis and the use of acid-base indicators.

- **TEKS HS**
  C.c.11.B: Distinguish among types of solutions, including electrolytes and nonelectrolytes and unsaturated, saturated, and supersaturated solutions.

  C.c.12.B: Define acids and bases and distinguish between Arrhenius and Bronsted-Lowry definitions.

- **TEKS MS**
  6.b.6.E: Identify the formation of a new substance by using the evidence of a possible chemical change, including production of a gas, change in thermal energy, production of a precipitate, and color change.

Materials Required

Polystyrene, Disposable, Sterile Petri Dish (top or bottom; 741250)

2 Connector Cords, 24" (with insulated alligator clips on both ends; 756521)

Industrial Alkaline Battery, 9 V (756318)

2 Pencil Leads (for mechanical pencil; paper clips also work)

Sodium Sulfate, Anhydrous, 500 g (891710)

Bogen Universal Indicator, 100 mL (848263)

Microchemistry Plastic Pipet (736984)

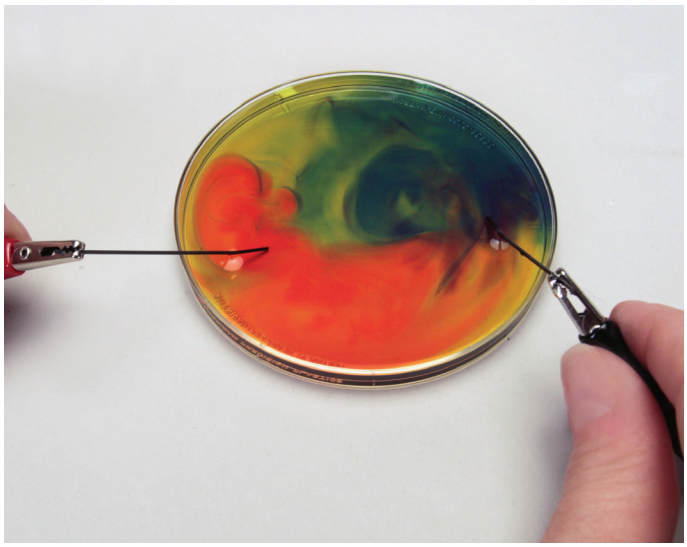
Water (tap, distilled, or deionized), 3.8 L (858621)

Carolina® Safety Spectacles (646700)

Safety
Follow and model basic laboratory safety rules. Wear safety glasses.

Activity Procedure

1. Fill the top or bottom of a petri dish with water until the surface is covered.
2. Add 0.5 mL of Bogen universal indicator solution to the water, and swirl to mix.
3. Add a small spatula of sodium sulfate to the water, and swirl to dissolve.
4. Attach 1 wire lead to each terminal on the 9-V battery using the alligator clips. Clamp a different pencil lead in each of the free ends of the wire leads.



5. Put the tip of each pencil lead in the solution. What happens?

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Results/Summary

When a charge is applied to water containing an electrolyte, the electrical energy causes the water to decompose into its elemental parts: hydrogen gas and oxygen gas. The balanced chemical equation for this reaction is as follows:

$$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$$

The above reaction is a reduction-oxidation reaction (redox) because hydrogen is reduced in the reaction (from +1 to 0) and oxygen is oxidized (from –2 to 0). Here are the 2 half-reactions:

Reduction (occurs at the cathode):
$4H_2O(l) + 4e^- \rightarrow 2H_2(g) + 4OH^-(aq)$

Oxidation (occurs at the anode):
$2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$

Adding the 2 half-reactions gives the overall equation.

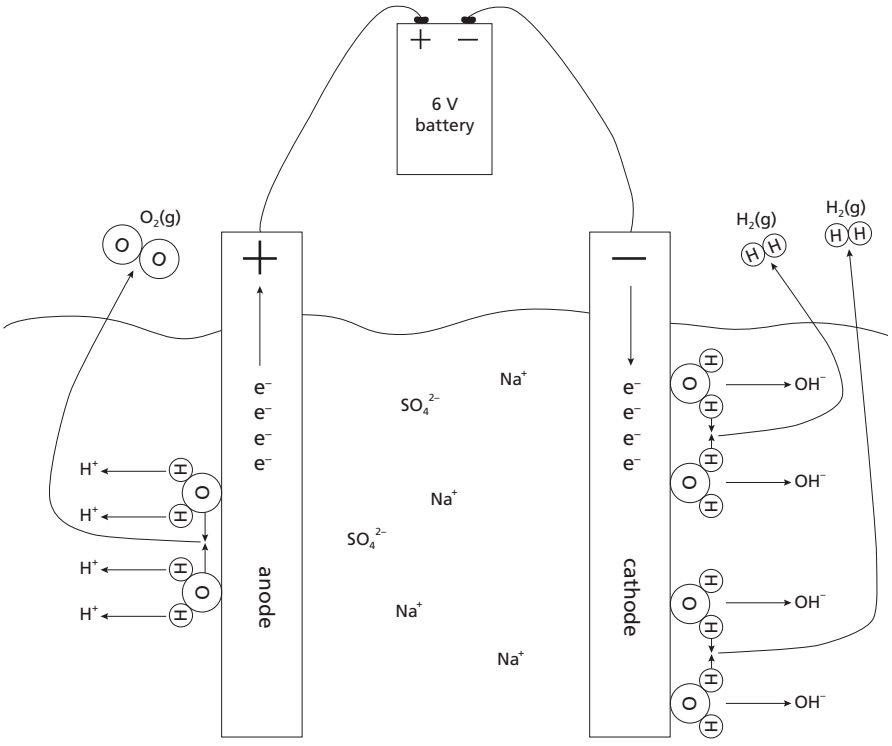
In the experiment, reduction of hydrogen occurs at the cathode (the pencil lead electrode connected to the negative battery terminal). Oxidation of oxygen occurs at the anode (the pencil lead electrode connected to the positive battery terminal). The electrolyte in this activity is sodium sulfate. This salt dissolves in water to form sodium and sulfate ions, which carry the charge between the electrodes.

When the experiment begins, the solution is green because the sodium sulfate solution has a pH of 7. As the reaction progresses, you will see a violet color develop at the cathode as hydroxide ions form and the solution becomes basic. At the anode, you will see a yellow or orange color as hydrogen ions form and the solution becomes acidic. In addition, you will observe bubbles of gas evolve at each electrode.

Additional Information

View more information, content links, and products related to this activity at www.carolina.com/takeaways.

Example Particle Level Explanation Diagram



Anode
O_2 gas produced
H^+ ions produced
Indicator turns pink (acidic)

Cathode
H_2 gas produced
OH^- ions produced
Indicator turns purple (basic)

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