Making Hydrogen - Extension Activity

| Tanner | 1 Hour | Grade 3-4

SUPERNOVA
DALHOUSIE UNIVERSITY | HALIFAX, NOVA SCOTIA

OVERVIEW

Description
Participants will continue to explore the concept of electrolysis by watching water split when mixed with different mediums

Learning Outcomes
- Learn about electrolysis
- Learn how electricity affects certain substances
- Learn about the difference between the positive and negative terminals of a battery

Outline *(with time indications/estimations)*
1. Introduce the activity (**5 minutes**)
    a. Remind participants what electrolysis is and how it is used to create hydrogen gas that is used as fuel.
2. Demo and Activity (**50 minutes**)
3. Debrief (**5 mins**)

Materials

Item (*be very descriptive*)	**Quantity Per Child** (*with units*)	**Quantity Per Lesson** (*with units*)
Metal Tacks	N/A	2
Clear Plastic Cups	N/A	2
Distilled Water	N/A	500mL
Baking Soda	N/A	1 pinch
Lemon Juice	N/A	A few drops
9V Battery	N/A	1

SAFETY CONSIDERATIONS

- Precautions for Instructor and Participants.
- Please use caution, and explain each safety measure to the participants. Ensure any incidents are reported appropriately.
- Indicate with an ‘x’ next to the items that apply to this activity.

Material/Chemical Safety	
	SDS Required (*attach in write up)*
x	Electrical Components
x	Food &/or Potential Allergens
	Other:
Equipment Precautions	
	Sharp Objects: Scissors/ Staplers/ Scalpel
x	Burn Risk: Glue Guns/ Hot Plate/ Flame
	Tools
	Other:

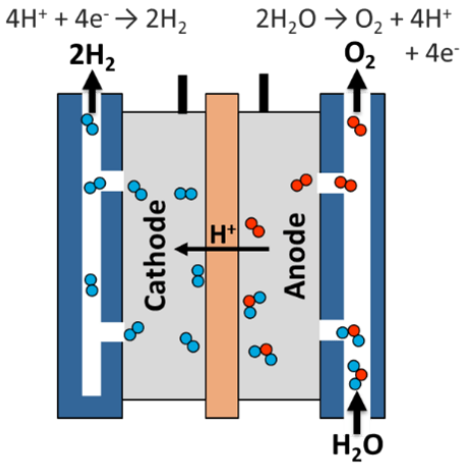
Digital Safety [ ] Yes [ ] No	
Special Clean-up Required? (indicate below)	
Safety Equipment or Protection	
	Goggles/ Gloves
	Lab Coat
	Fire Extinguisher
	Other:
Other Safety Precautions? (indicate below)	

KEY INFORMATION

Information on the activity topic(s) that is necessary for the Instructor to be familiar with.
(Suggested 300 words)

How hydrogen gas is created by electrolysis:

Electrolysis is the process that uses electricity to separate water (H2O) into hydrogen and oxygen. This reaction occurs in a unit called an electrolyzer consisting of an anode and a cathode separated by an electrolyte. Different types of electrolyzers are the Polymer Electrolyte Membrane (PEM), Alkaline and Solid Oxide. For the toy car, PEM is used and in the PEM, the electrolyzer is a special solid plastic material.



Water enters the system and reacts at the anode to form oxygen and positively charged Hydrogen ions (protons). Through an external circuit, electrons flow from the anode to the cathode while the Hydrogen ions selectively pass through the electrolyte in the PEM to the side of the cathode. At the cathode, the hydrogen ions combine with electrons from the external circuit to form hydrogen gas.

LESSON PLAN AND PROCEDURE

- *Should reflect Overview-Outline.*
- *Include any necessary inclusion and/or adaptation information.*
- *Refrain from including additional background information on the topic, instead refer back to the Key Information section, where necessary.*
- *Make note if anything needs to be prepared beforehand.*

Title

1. Remind students about the process of electrolysis and how it is used to create hydrogen gas (**topic 1**). Hydrogen gas is a clean fuel because when it is consumed, it only produces water. No harmful emissions.
2. Begin Demo **(There is a question sheet on the next page that you can give to students to answer at the end of the demonstration)**
3. Have students come up to you in a way that they can all watch the demonstration. Give students a blank piece of paper to write observations.
4. Carefully push the two metal thumb tacks into the bottom of the plastic cup so that the sharp ends are in the cup. The tacks should be spaced so that they are aligned with the terminal of a 9V battery.
5. Now fill up the cup with distilled water until the pointy ends of the tac are completely submerged.
6. Add a pinch of baking soda.
7. Now it is time to add electricity to the water from the batter. To do this, stand the battery up and place the cup on top in a way that each thumb tack is touching one of the terminals of the battery.
8. Have students record their observations.
9. Discard the solution (**safe to go down the drain**), and repeat the procedure three more times with the followings differences:
    a. Add lemon juice instead of baking soda
    b. Don't add anything (**skip step 3**)
    c. Use tap water instead of distilled water

Debrief

- *Any concluding remarks and/or points of reflection*
- *Recap or review of material relating to key learning outcomes*
- *Application/ 'further connections' questions*

<u>Debrief Questions</u>

1. Based on what you saw from the experiment, what is needed to make hydrogen?

2. How did the different solutions impact the water splitting? Do you think certain solutions were better than others? Use your observations from the experiment to support your answer.

3. Do you think it was hydrogen or oxygen that formed on the positive terminal of the battery? Please explain your reasoning.

Answers to Debrief Questions

Q. Based on what you saw from the experiment, what is needed to make hydrogen?

A. The main thing we need is electricity, but that is not the only thing. You also need metal and water that has ions in it. Pure water doesn't conduct electricity.

Q. How did the different solutions impact the water splitting? Do you think certain solutions were better than others? Use your observations from the experiment to support your answer.

A. Observations will support that the amount of bubbles surrounding the thumb tacks indicates how much gas is produced.

Overall, the baking soda and lemon juice worked the best, followed by tap water and lastly distilled water. For the distilled water, no bubbles should have been produced due to its low electrical conductivity.

Q. Do you think it was hydrogen or oxygen that formed on the positive terminal of the battery? Please explain your reasoning.

A. Oxygen is formed at the positive terminal and hydrogen is formed at the negative terminal. Based on the chemical equation of water splitting, it is shown that more hydrogen is produced than oxygen. During the experiment it should have been found that more bubbles formed at the negative terminal, thus determining that one must be hydrogen.

Anode Reaction: $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$ ***Cathode Reaction:*** $4H^+ + 4e^- \rightarrow 2H_2$