Chemical Reactions

Goals

- Understand how chemical reactions work
- Perform a reversible reaction
- Make calculations based on data

Background

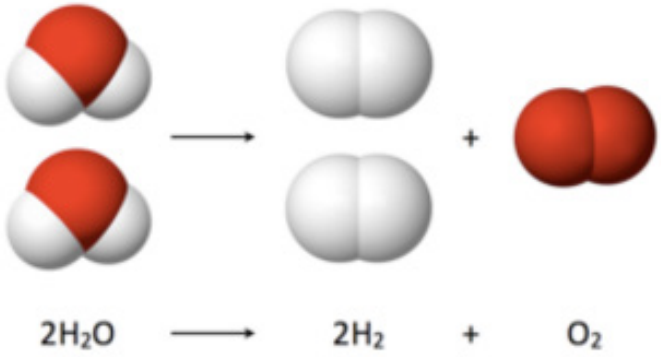
Chemical reactions are the processes that create every compound in the universe. When two or more atoms form a bond, or break bonds and form new ones, a chemical reaction takes place that totally changes the characteristics of the materials involved.

Some chemical reactions are ones where simple substances are combined to make new, more complex compounds (synthesis) or where complex molecules are broken down into simpler molecules (decomposition). Water, one of the most common substances on Earth, is easily synthesized from hydrogen and oxygen, and also can be easily decomposed back into hydrogen and oxygen.

We can write out these reactions using chemical symbols like this:

$2\ H_2 + O2 \rightarrow 2\ H_2O$
$2\ H_2O \rightarrow 2\ H_2 + O_2$

A hydrogen fuel cell can accomplish both of these reactions by using electricity. Running an electric current through the fuel cell when it's filled with water causes the water to split into hydrogen and oxygen. If the fuel cell is attached to a motor while oxygen and hydrogen are present, it will combine them into water and produce an electric current that powers the motor. To learn more about how a hydrogen fuel cell works, click here.



To find out more about how these chemical reactions work, we'll use the hydrogen fuel cell to power a small car, first by producing hydrogen and oxygen gas, then using those gases to generate electricity.

Procedure

1. Once the fuel cell starts producing hydrogen and oxygen gas from water, we will need to trap the gases to be able to use them for the reverse reaction. How can the gases be trapped using the materials provided?
2. The Oxygen side of the fuel cell needs to be filled with water. Observing the hydrogen fuel cell, why do you think only one side needs to be filled with water? Do you think it matters if the water is injected into the top or bottom outlet?
3. How can we tell how much gas has been generated from our reaction?
4. Does it matter how the battery pack is attached to the fuel cell? Why or why not?
5. If you're ready to capture the gases produced by the fuel cell, attach the battery pack. Observe what happens and record your observations below.

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Observations

Experimentation

1. You've produced hydrogen and oxygen from water. Now, connect the fuel cell to the motor. What happens?

2. Generate more hydrogen and oxygen using the fuel cell, as before. Can you tell how much hydrogen you've generated? What is the volume of hydrogen produced?

3. What is produced faster: hydrogen or oxygen? Why do you think this is?

4. How would you make more gas with this reaction? Devise an experiment that you could run to increase the amount of hydrogen and oxygen you produce. Describe your experiment below.

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Measurement

For this section, you will need a multimeter or the Horizon Renewable Energy Monitor. For an introduction to using a multimeter, click here.

1. Measure the current in Amps and the voltage in Volts while generating hydrogen and oxygen. Record your answers below:

Current: _____ A

Voltage: _____ V

2. Voltage is equal to the current multiplied by the resistance (V = IR), so according to your data what is the resistance of the fuel cell?

Resistance: _____ Ω

3. Measure the current in Amps and the voltage in Volts while combining the hydrogen and oxygen to produce water. Record your answers below:

Current: _____ A

Voltage: _____ V

4. Does it take more energy to split the hydrogen and oxygen or combine them? Explain your reasoning.

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Analysis

1. Make a scientific claim about what you observed while running the fuel cell.

2. What evidence do you have to back up your scientific claim?

3. What reasoning did you use to support your claim?

4. Use your observations to design an experiment you could run to increase the amount of electricity generated by the fuel cell. Describe your experiment below.

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Conclusions

1. How would you describe what happened during the decomposition and synthesis reactions you just observed in terms of the energy involved?

2. Did all of the energy in the hydrogen transform into electrical energy? If not, where else did it go?

3. What kinds of measurements could you make to confirm that energy was conserved during these reactions?