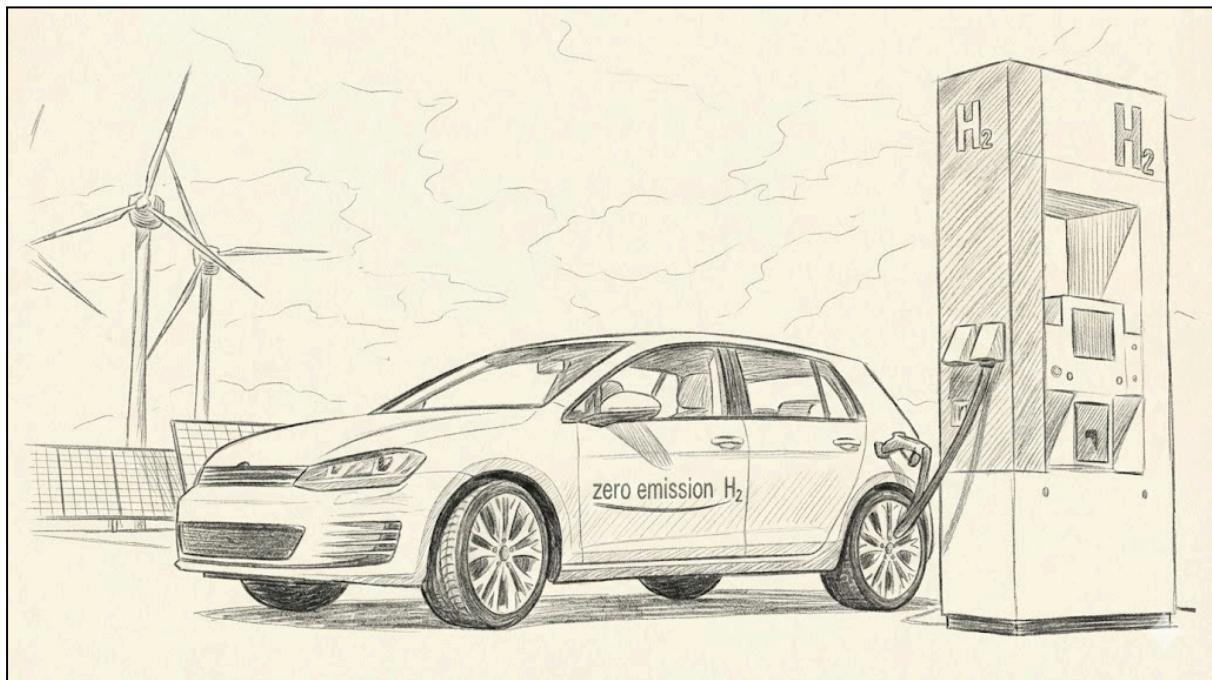


Hydrogen! Distant future, or reality?



Introduction

In recent years, we have been working with our senior STEM students on climate challenges. The focus then was on measuring air quality. However, vehicle emissions are a significant contributor to this pollution. Let's examine a cleaner alternative.



Teamwork

For this assignment, I worked with:

1

2

3



**atheneum
brakel.**

Tom Demortier
2025 - 2026

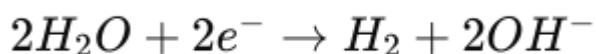
What is Hydrogen?

Hydrogen gas is a promising energy source for the future because it can help us use cleaner energy. One way to produce hydrogen gas is by splitting water using electricity; this process is called electrolysis.

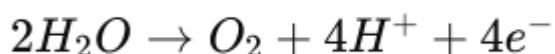
In water electrolysis, an electric current is passed through water, causing the water (**H₂O**) to break down into hydrogen gas (**H₂**) and oxygen gas (**O₂**). This takes place in a device called an electrolytic cell, which has two electrodes: a cathode and an anode.

Here is how it works:

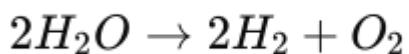
1. **Cathode (-):** This is the negative electrode. Here, water molecules gain electrons and turn into hydrogen gas (H₂) and hydroxide ions (OH⁻).



2. **Anode (+):** This is the positive electrode. Here, water molecules release electrons and turn into oxygen gas (O₂), hydrogen ions (H⁺), and electrons."



When you combine the reactions at the cathode and the anode, you get the overall reaction:



This means that for every water molecule you split, you produce twice as much hydrogen gas (H₂) as oxygen gas (O₂).

Water electrolysis is therefore a clean technology because no pollutants are released.



However, the source of the electricity used for the electrolysis is important. If this electricity comes from green energy sources such as solar or wind energy, then the production of hydrogen gas is also environmentally friendly. This can help reduce the emission of harmful gases and combat climate change.

Sustainable “green” hydrogen production!

To produce hydrogen gas, we need electricity. However, how environmentally friendly hydrogen gas is depends on the source of that electricity:

- **Wind energy**

Wind turbines convert wind into electricity. If we use this electricity for electrolysis, we produce hydrogen gas without harmful emissions.

- **Solar energy**

Solar panels convert sunlight into electricity. This electricity can also be used for electrolysis, meaning we produce hydrogen gas using the power of the sun.

- **Hydropower**

Hydroelectric power plants use flowing water to generate electricity. This is another method of obtaining clean energy for producing hydrogen gas.

When we use green energy sources to produce hydrogen gas, we avoid using fossil fuels such as coal, oil, and gas. Fossil fuels are polluting and contribute to climate change because they emit CO₂ and other harmful substances when burned. By switching to green energy, we can produce hydrogen gas in an environmentally friendly way.

This means that hydrogen gas can play a major role in a cleaner future. It can be used as fuel for cars, buses, and trains, or as an energy source for homes and factories. Since it produces no harmful emissions when used, it can help improve air quality and combat global warming.



Properties of hydrogen

Storing hydrogen gas is challenging because it easily escapes through the smallest openings. As soon as it escapes, it disappears almost immediately. But did you know that 90% of our universe consists of hydrogen gas? On Earth, pure hydrogen is rare because it is so light that it rises into space. Hydrogen is abundant on Earth in compounds with other elements, such as in water.

Assignment 1

Indicate whether the following properties are an advantage or rather a disadvantage. Briefly explain why you think so.

- It is a colorless, odorless gas → **advantage or disadvantage?**

Why?

- It is a non-toxic gas → **advantage or disadvantage?**

Why?

- It is highly flammable → **advantage or disadvantage?**

Why?

- When it burns, the flame is invisible → **advantage or disadvantage?**

Why?



Conclusion: pros and cons

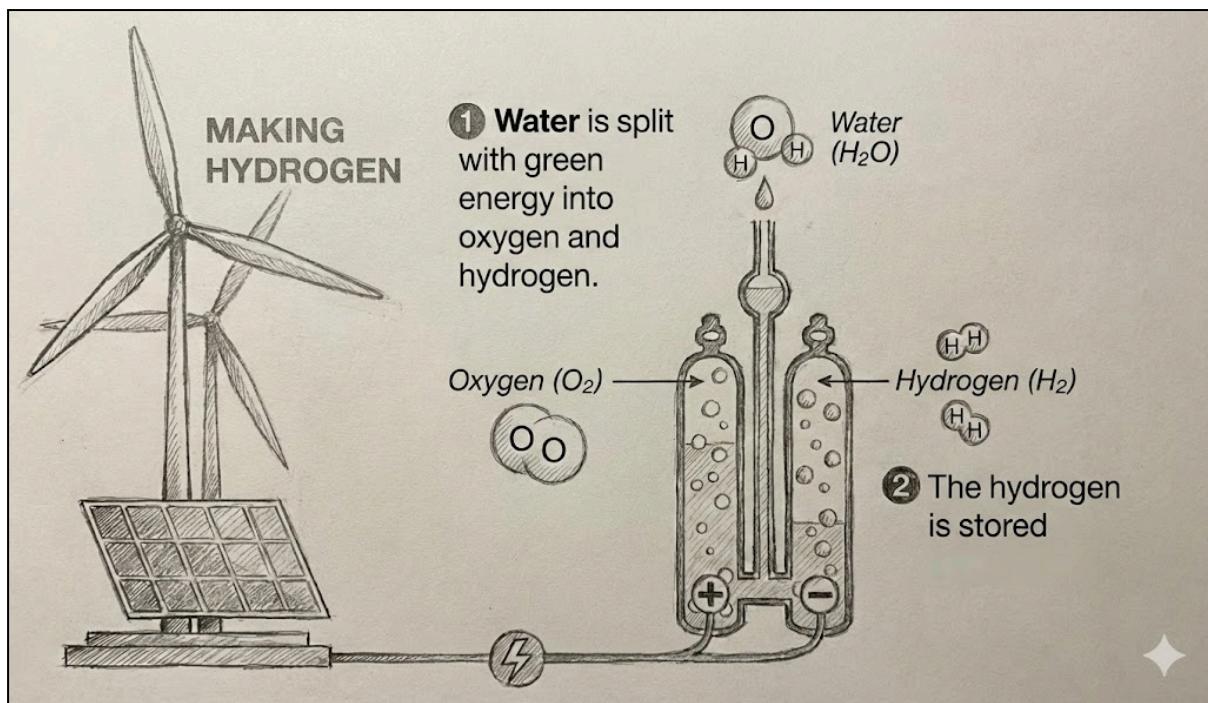
Pros

- The use of hydrogen gas is not environmentally polluting. Unlike fossil fuels, it does not produce carbon dioxide (CO₂). Only water vapor is produced during the combustion of hydrogen gas.
- Hydrogen gas is a virtually inexhaustible resource. New hydrogen gas can constantly be produced using electricity. Furthermore, this electricity can always be generated in a green way.
- Hydrogen gas can be stored as a form of energy. By using surplus electricity to produce hydrogen gas, we can store energy in the form of hydrogen.
- Due to the use of fuel cells and the elimination of mechanical parts, a very quiet propulsion system is possible.

Cons

- Hydrogen gas has a very low density. Therefore, it will escape through even the smallest opening in a tank. As a result, a large hydrogen tank would be needed for a small amount of hydrogen gas. This is not feasible in a car. However, we can store hydrogen under high pressure (350 bar) in special tanks for cars, and in tanks of up to 700 bar for buses.
- There are currently few to no hydrogen fueling stations where people can refuel if they own a hydrogen car. As long as there are no fueling stations, no hydrogen cars will be sold.
- As indicated in the properties, hydrogen gas is highly explosive. Therefore, it can be dangerous!





Assignment 2

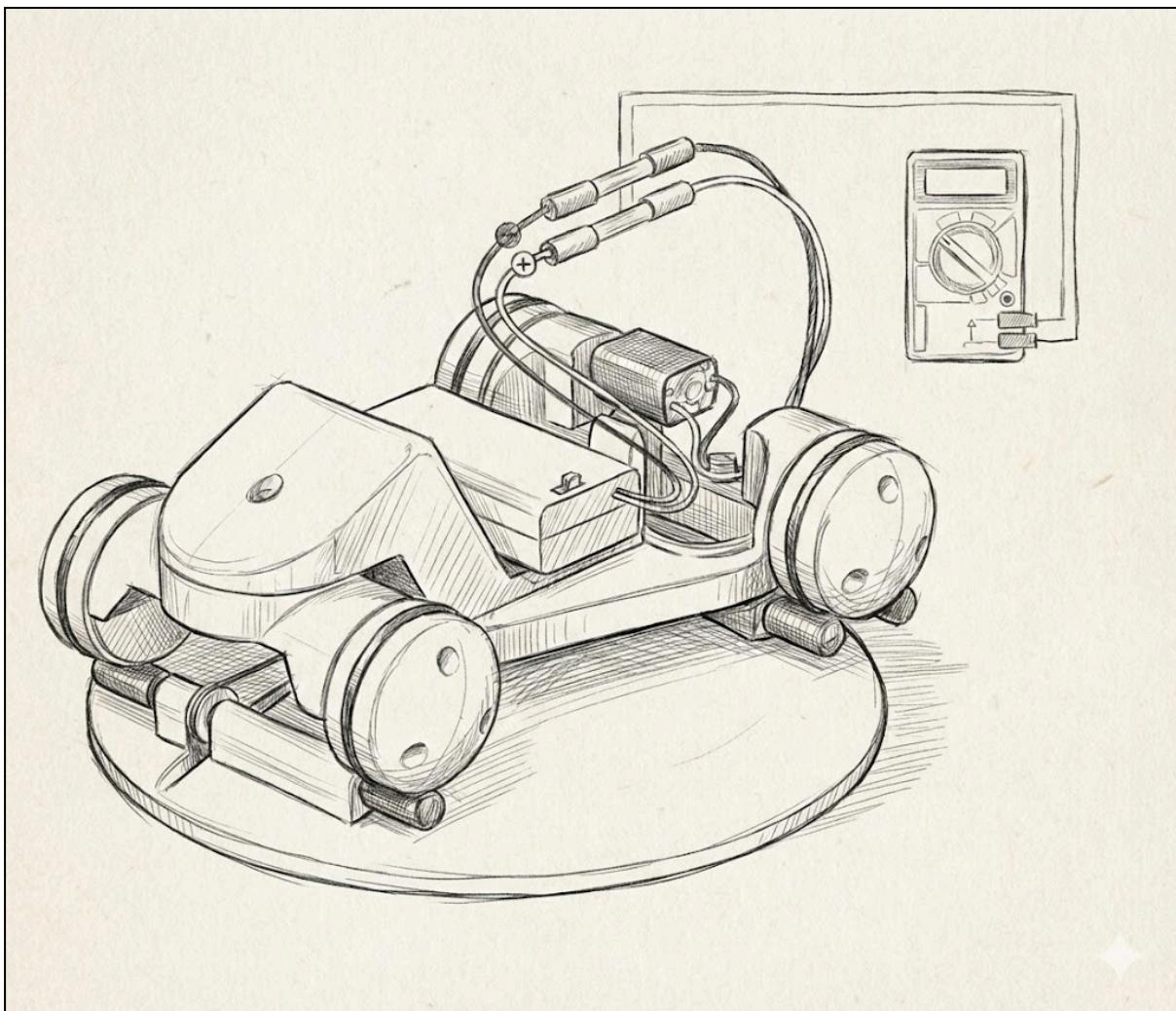
Research and explain in your own words how our fuel cell car operates.



Getting started with the hydrogen car!

Assignment 3

- Use the batteries as the power source to drive the car.
- Measure the voltage (Volts) of the power source with the digital multimeter.

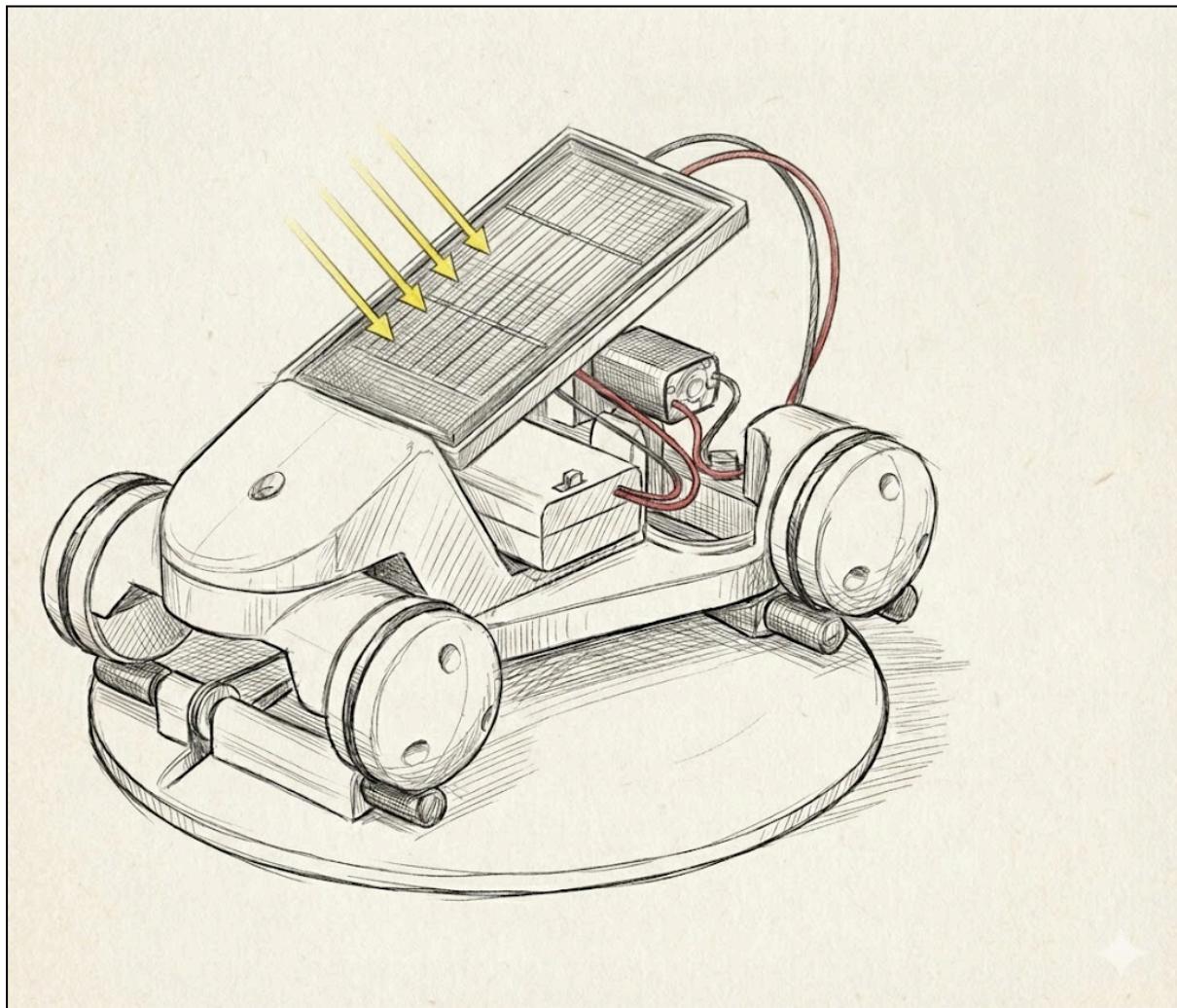


I measure a voltage of:



Assignment 4

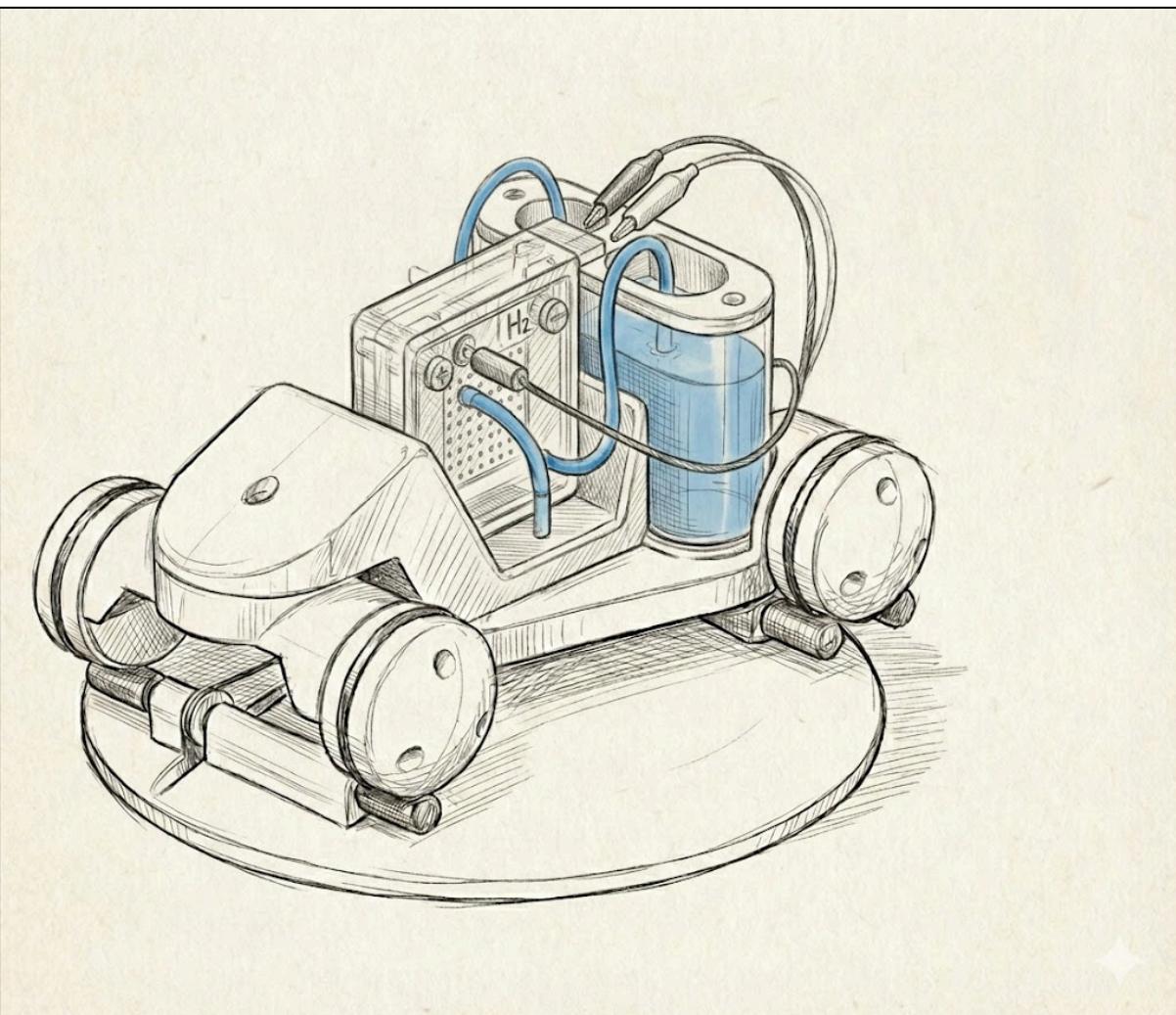
- Use the solar panel as the power source to drive the car.
- Measure the voltage (Volts) of the power source with the digital multimeter.



	Solar panel horizontal	Solar panel 45° towards the Sun	Solar panel away from the Sun	Battery	Fuel cell
I measure					

Assignment 5

- Use the fuel cell as the power source to drive the car.
- Measure the voltage (Volts) of the power source with the digital multimeter.
- Use the manual to prepare the fuel cell so that it can provide energy



I measure a voltage of:



Assignment 6

Write a brief conclusion of your research and explain which energy source you prefer and why (not everyone in the group needs to share the same opinion).

Extension

- Measure the voltage of the solar panel directly using the digital multimeter.
- Move the solar panel to different spots in the classroom and take measurements each time.
- Also change the angle of the solar panel relative to the sun/light source to see if this affects the voltage.

Location	Measurement	Measured at an angle of

Conclusion

