



**Model No.: RESK-02B-1/RESK-02B**

**Do-it-Yourself Fuel Cell Kit/Classroom Pack**



## **Warning!**

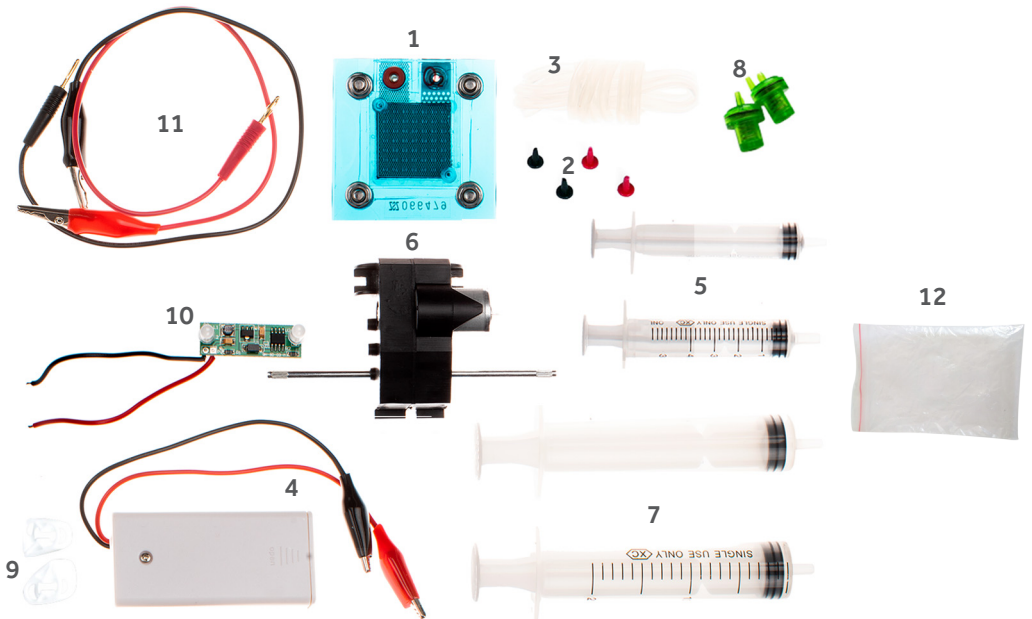
To avoid the risk of property damage, serious injury or death:

This kit should only be used by persons 12 years old and up, and only under the supervision of adults who have familiarized themselves with the safety measures described in the kit. Keep small children and animals away, as it contains small parts that could be swallowed. Read the instructions before use and have them ready for reference.

## List of components

RESK-02B-1	
1.	Reversible fuel cell 1
2.	Set of red and black pins 1
3.	Set of silicone tubing 1
4.	Battery pack with crocodiles 1
5.	(5ml) Syringe 2
6.	Motor 0.6V 1
7.	(20ml) Syringe for storage of Hydrogen and Oxygen 2
8.	Pressure relief valve 2
9.	Plastic clamp 2
10.	LED diode 1
11.	Wire set 1
12.	Bag to protect fuel cell 1

RESK-02B	
1.	Reversible fuel cell 12
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3.	Set of silicone tubing 12
4.	Battery pack with crocodiles 12
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6.	Motor 0.6V 12
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8.	Pressure relief valve 24
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11.	Wire set 12
12.	Bag to protect fuel cell 12



## **Safety Information**

Before you start working with the Horizon DIY take notice of the following. Under certain circumstances, hydrogen can create an explosive gas mixture. Though these devices in this box are designed such that they can be used as described without danger, the advice below must be followed at all times:

- The fuel cell and hydrogen storage may not be operated without supervision of adult person.
- Hydrogen ( $H_2$ ) is much lighter than air and thus rises rapidly. In conjunction with oxygen, a gas mixture capable of explosion can form. A potentially explosive mixture arises for hydrogen concentrations from 4.0 to 77.0% in air. Therefore, it holds that:
- The fuel cell must only be operated either outside or in sufficiently ventilated rooms.
- Oxygen ( $O_2$ ) is a strongly oxidizing gas. When this gas gets in contact with organic substances (e.g. oil, grease) spontaneous combustion may occur at room temperature.
- Do not insert the cables into an electrical outlet.
- Do not connect the fuel cell or motor to other power sources.
- The removing and inserting of batteries is to be conducted by the adults only.
- **Ensure to respect the polarity.**
- Non-rechargeable batteries are not to be recharged.
- Different types of batteries such as rechargeable, alkaline and standard batteries or new and used batteries are not to be mixed and should be used separately.
- The battery pack cables are not to be inserted into an AC socket.
- The supply terminals of the battery pack are not to be short-circuited.
- The two spare red & black cables are not to be inserted into an AC socket.
- Exhausted batteries are to be removed from the battery pack.
- Dispose of dead batteries properly and without delay.
- Do not attach the battery wires directly to each other.

## Safe Experimentation

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Here are some important instructions for parents, teachers, and students. All activities described in this manual can be conducted without risk if you follow instructions and rules conscientiously. To avoid the risk of property damage, serious injury or death:

1. Read carefully and fully understand the instructions before assembling this kit.
2. This product is intended only for use by persons 12 years old and up, and only under the supervision of adults who have read and understood the instructions in this user manual.
3. Pay special attention to the indications of quantity and to the sequence of the individual steps.
4. Some parts are small and fragile: please be careful when handling and connecting parts to avoid damage. Handle all parts and components with care.
5. Do not attempt to disassemble any part, item or component in this kit.
6. Keep small children away, because this kit contains small parts that could be swallowed.
7. Wires are not to be inserted into socket-outlets.
8. Save these instructions and review frequently during use.
9. Do not eat, drink, or smoke near the fuel cell device and hydrogen storage.
10. Use fuel cell and hydrogen storage only at a site with good ventilation and keep all sources of ignition away.
11. Clean your hands after use.
12. **After using the reversible fuel cell, connect the silicon plugs to the nozzles, and seal the fuel cell in a zip bag. Improper storing may lead to membrane drying out, which may consequently result in the fuel cell damage.**

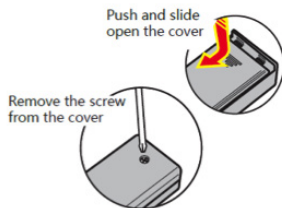
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## Operation Guide

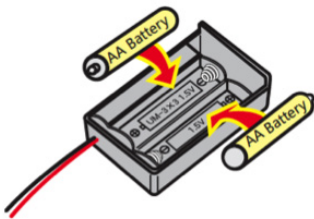
This guide will give you enough information to assemble your first carbon free powertrain.

### 1.1 Using the Battery Pack to Perform Electrolysis



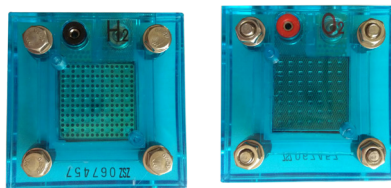
Please remove the screw from cover of battery box using a screw driver. Push and slide the cover and open the battery box. Try NOT to touch the cables when you open the cover.

Place two AA batteries as indicated, please note polarity. Push and slide the battery box cover to closed position and screw tightly into place using screw driver.



- Make sure the switch on the battery box is in the "off" position before you place the batteries into the box.
- Avoid any contact between the battery and water.
- **WARNING:** If the cable is short circuited the batteries inside could become hot and potentially cause burns, melting of parts, or create risk of fire.

### 1.2 Produce hydrogen (Electrolysis)



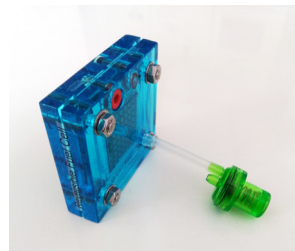
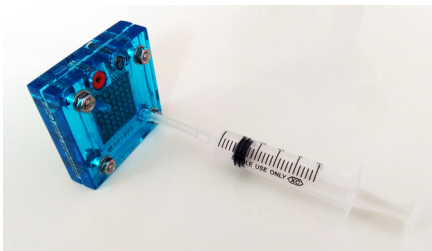
A fuel cell has both a negative (Hydrogen) and a positive (Oxygen) side. While using the reversible fuel cell as an electrolyser it's important to make sure the polarities (red to red & black to black) are correct otherwise the fuel cell can be permanently damaged.

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First step of the fuel cell assembly is the preparation of the flexible plastic tubing. Cut (2) 3cm long pieces and connect one to both of the pressure relief valves. Then cut a 12cm long pieces and connect to both of the 20ml syringes for storing hydrogen and oxygen. Finally, cut a 5cm long piece of flexible plastic tubing and connect to the 5ml syringe for injecting the water.



### Step 1 – Hydrating the Membrane

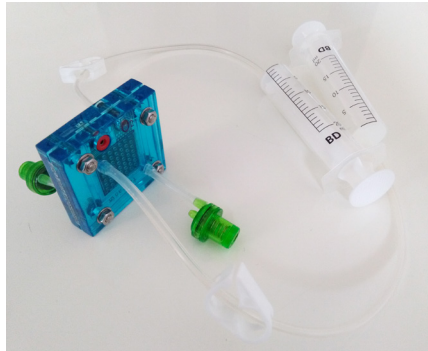


The membrane of the fuel cell can be hydrated by adding distilled water (regular water can damage the fuel cell) to the Oxygen side of the fuel cell. Start by drawing ~1mL of distilled water into a syringe and inject the distilled water into the bottom nozzle on the Oxygen side of the fuel cell (some water might leak from the top nozzle). Never operate the fuel cell without insuring that there is water in the oxygen side. Once filled, remove the syringe and attach a pressure relief valve to this nozzle.

Next, attach a pressure relief valve to the lower nozzle on the Hydrogen side. It's important to note that this side should be kept dry so check and make sure the tubing is dry!

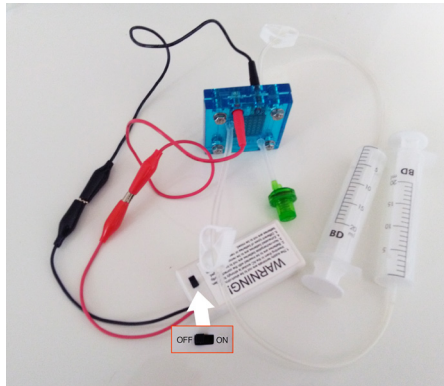
## Operation Guide

### Step 2 – Connecting the Syringes



Attach a syringe to the top nozzle on each side of the fuel cell (these will be for gas storage).

### Step 3 – Electrolysis



Connect the red & black lead cables to the fuel cell. During this process make sure the battery pack is turned off! Attach the red and black cables from the battery pack to the crocodile clips that are connected to the fuel cell (make sure the red and black leads do not touch each other – this would create a short circuit!).

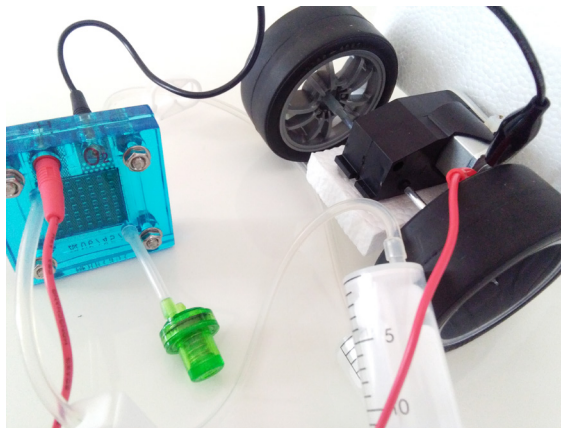
Connect the red lead to the Oxygen (red) side and the black lead to the Hydrogen (black) side. Once these proper connections are made, turn on the battery pack and



## Operation Guide

the electrolysis process will begin. Turn the battery pack off once enough hydrogen has been produced and disconnect it from the fuel cell. Once again, pay close attention to ensure that the cables do not touch each other.

### 1.3 Power the system



A fuel cell has both a negative (Hydrogen) and a positive (Oxygen) side. While using the fuel cell it is important to make sure the polarities (red to red & black to black) are correct as it will affect the direction of the motor. This means the car will drive backwards if you switch the polarity.

#### Step 1

Attach the the red lead to the motor contact with the red dot and attach the black lead to the other contact on the motor (negative). **Make sure these connections are tight, do not allow the other ends of the leads to come in contact with each other – that would create a short circuit!**

#### Step 2

Attach the other end of the red lead to the Oxygen (red - positive) side of the fuel cell; attach the other end of the black lead to the Hydrogen (black - negative) side.

## Troubleshooting

1. You will also need the following items (not included in this kit): - AA batteries
2. The reversible fuel cell does not produce hydrogen and/or oxygen. Solution:
  - a. Check whether the wires are appropriately connected, and whether there are any loose connections.
  - b. The fuel cell could be completely destroyed if the red wire of the battery pack is connected to the black socket of the fuel cell.
  - c. Check whether the switch of the battery pack is in the "on" position.
3. The water electrolysis process slows down. Solution:
  - a. Add water to the oxygen side of the fuel cell and wait for about 5 minutes.
  - b. Replace old AA batteries with new AA batteries inside the battery pack.
4. The car stops moving while there is still hydrogen left inside the tanks. Solution:
  - a. Purge the gases and perform water electrolysis for 4-5 minutes. Unplug the hydrogen gas outlet tube and oxygen gas tubes to purge the gases. Perform water electrolysis again until the hydrogen syringe is filled, and connect the motor to the fuel cell. If the problem persists, go to the next step.
  - b. Let the water electrolysis process last about 10 minutes to consume the residual water. To push water out of the fuel cell, purge the gases. Perform water electrolysis once more until the hydrogen tank is filled, then connect the motor to the fuel cell.

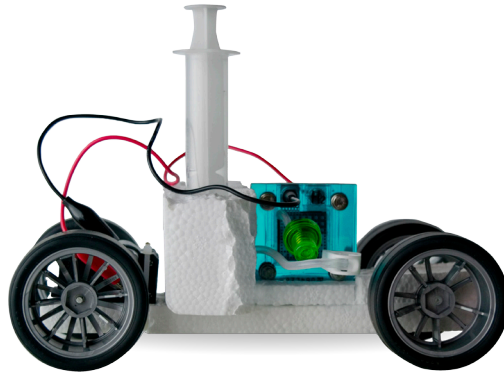
The aim of the DIY-kit is to provide an open-ended learning experience of hydrogen fuel cells and all the exciting science that comes along with this technology. Below you can find a few projects that can be built with additional material that can be found in most homes, schools or science labs. For more information about all the chemistry, physics and earth science behind these technologies check out and download our free E-book and lesson plans online; [www.horizoncurriculum.com](http://www.horizoncurriculum.com)

**Note; tools and material mentioned in the project are not part of DIY kit.**

**Note; always make sure to have an adult around while building your own project who knows how to use the suggested tools for the projects below.**

## Sample projects

### 1.4 Car



This car is powered by a zero emission fuel and it can with help from the included motor drive both forward and backward. Create your own car and race with other classmates who will drive longer distance on single „tank“ of hydrogen. For this race you have to create your car as light as possible!

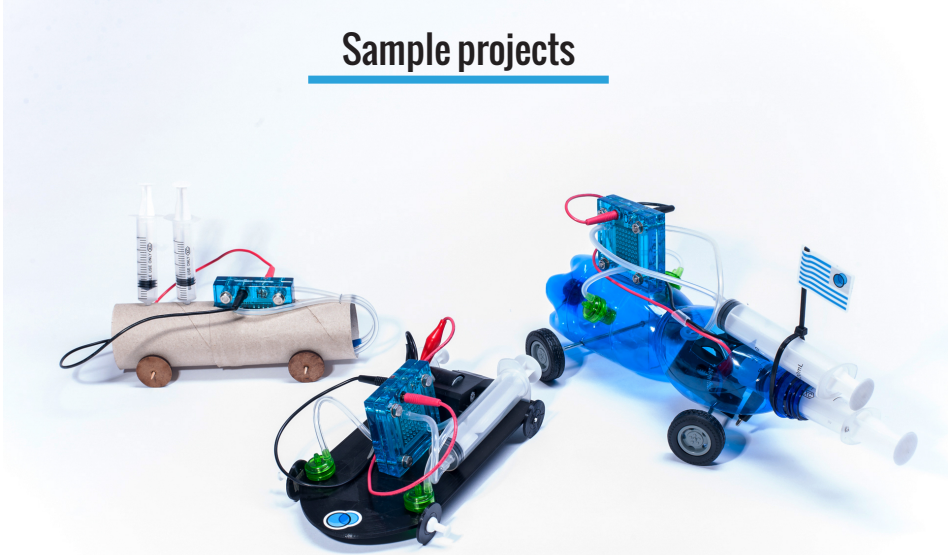
**Tools:** carpet nife, soldering iron (it is very good for cutting polystyrene but it is not necessary), melting gun, ruler, sketchbook, pencil, brush.

**Material (car chassis):** polystyrene, plastic straps, plastic tube/rod, silicon hose, wheels (it does not matter what kind of wheels, you can also create them or use wheels from a building kit), glue, temperas (paint) for coloring, Horizon gearbox with electric motor, assembled reversible fuel cell.

Alternative tools: whatever you and your superwising adult are trained and comfortable using

Alternative material: recycled wood plank, plastic, aluminium, cartoon sheet, etc.

## Sample projects



### 1.5 Robot

If you do not want to use the motor as the output but rather the blinking diodes then lets build something artsy! Create your own robo-buddy, a christmas tree or a dragon! The choice is yours as long as you use the fuel cell to power the diodes and lots of your own creativity!

**Tools:** carpet nife, scissors, melting gun, ruler, sketchbook, pencil, brush.

**Material (robot body):** cartoon, paper, glue, temperas (paint) or watercolors for coloring, Horizon LED diodes, assembled reversible fuel cell, etc.

Alternative tools: whatever you and your superwising adult are trained and comfortable using  
Altrenative material: recycled wood plank, plastic, aluminium, cartoon sheet, polysteren, etc

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## IMPORTER

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