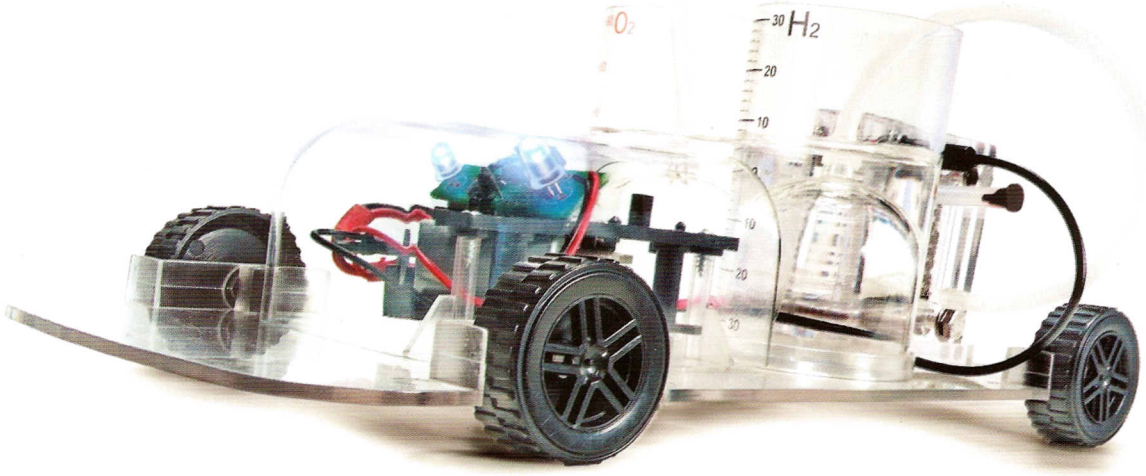
User Manual



Recommended for ages 12+

FUEL CELL CAR SCIENCE KIT

Powered by Horizon

I. Introduction to Hydrogen Fuel Cells

a. Why Hydrogen?

The world civilization consumes carbon-based fossil fuels 100,000 times faster than they are being made available, raising many questions about global supplies and whether they are able to meet the world's fast-growing global energy demand. With geopolitical uncertainties in oil producing countries and insufficient oil refining capacity, our global economy is already under significant pressure. Oil is critical to the well-being of entire nations, therefore new technologies that can reduce the dependence on imported oil are becoming strategic. National security concerns are now encouraging scientists from all over the world to develop new energy technology solutions such as hydrogen fuel cells.

An even greater issue has to do with the consumption of oil itself. Fossil fuels contain carbon, and burning gasoline in our cars creates toxic air pollution in our cities and contributes to massive amounts of carbon dioxide being released into our atmosphere. Carbon dioxide accumulation is the cause of greenhouse effects and global warming. For more than 100 years, humans have burned tremendous amounts of carbon-based fuels, causing our atmosphere to heat up. Global warming can now be witnessed by increasingly violent storms, desertification, shrinking mountain glaciers, melting polar ice caps, changing ocean currents and rising sea water levels.

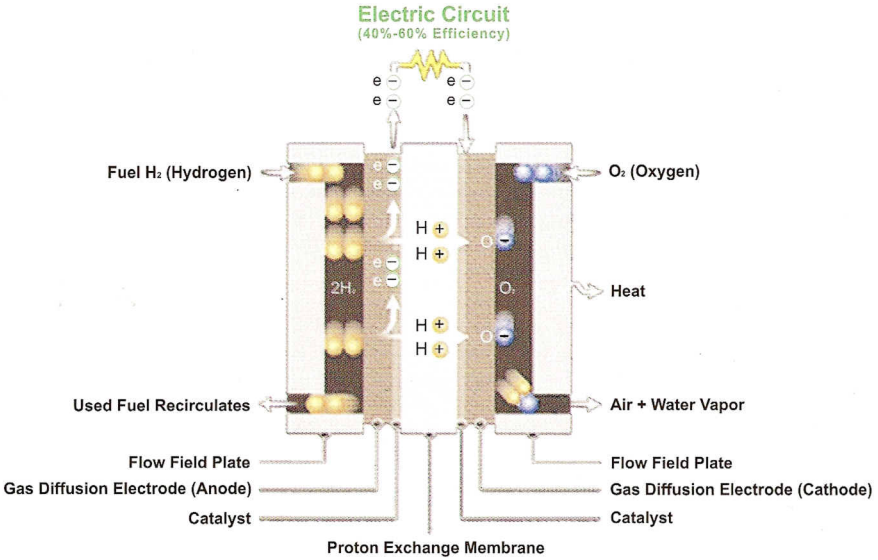
Our society needs a new and renewable fuel, and hydrogen is the best solution for the long term.

Indeed, hydrogen is the most abundant element in our universe and carries the most energy per unit of weight. This carbon-free fuel can be produced either by using traditional or renewable power sources such as solar or wind power. Once captured, hydrogen can be converted back to usable energy in numerous applications, including cars. This means our every day fuel can be produced locally, and in unlimited quantities. When it is consumed in the fuel cell, the result is electricity and water. This water can then be used to produce hydrogen and oxygen, making the cycle continuous and natural, with no toxic emissions. There are many challenges to making this a reality, but it's only a matter of time... ...and human ingenuity!

Around the world, several "Hydrogen Highway" projects are being developed and over 200 hydrogen refueling stations have already been built to service the first fuel cell cars.

b. What is a fuel cell and how does it work?

A fuel cell is a device that can convert hydrogen to usable electric power. The fuel cell is an assembly of advanced material layers where hydrogen and oxygen react with each other to generate electricity and water, without any combustion.



Serious interest in fuel cells did not begin until the 1960's, when they were used as power for mans first missions to the moon. Although fuel cells still provide electricity and water for today's space missions, this unique technology is now aimed at promoting a global transition to renewable energy sources. Fuel cell cars that use hydrogen as fuel are called "zero emission vehicles." If fuel cell cars were to use hydrogen produced by renewable sources of energy such as solar or wind power, our fuel supply would be unlimited - and consumption of hydrogen through fuel cells would not create any waste nor air pollution.

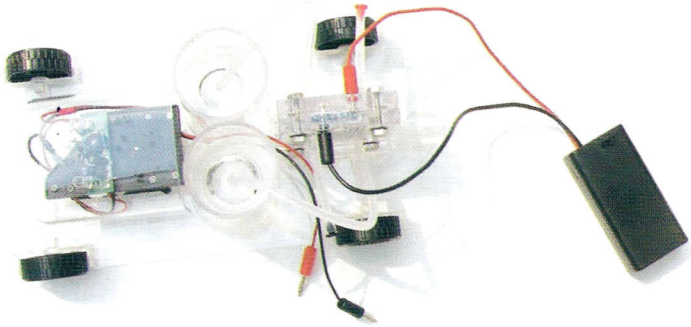
The **Fuel Cell Car Science Kit** uses a reversible Proton Exchange Membrane (PEM) fuel cell (see section 3, List of components - part E). It generates electrical energy by consuming hydrogen located in the on-board hydrogen storage cylinder (see section 3, List of parts and components, part H) which reacts with oxygen, which is also created and stored on-board the car.

5. Electrolysis: create Hydrogen from water

Electrolysis is the process of converting electrical energy to chemical energy. When a chemical charge is applied to water, the charge breaks the chemical bond between hydrogen and oxygen and creates charged particles called ions. In this case, positively charged hydrogen ions and negatively charged ions are formed. An electrolyzer has 2 electrodes where the ions form. One electrode, called the anode, is positively charged, and attracts negatively charged ions. The other electrode is called the cathode and attracts the positively charged hydrogen ions.

Reversible fuel cells can be used to perform electrolysis. In a fuel cell, the electrolyte is part of the membrane assembly. When a current is applied to a fuel cell, it will electrolyze water producing hydrogen on the cathode side and oxygen on the anode side.

Note: Follow these next instructions only after you have completed all the steps in Chapter 4: "Assembly of the car kit ". Make sure the fuel cell has been hydrated by injecting water using the syringe before proceeding to electrolysis.



Step 3: Switch the battery pack to the "on" position to start electrolysis. You will know oxygen and hydrogen gases are being produced when water is displaced to the top of the water storage cylinders. You can also measure the gas produced by measuring what looks like empty space gradually increasing in the top of the inner cylinders (this takes approx 5 minutes). When the hydrogen inner cylinder is full of hydrogen gas, you will begin to see bubbles coming out of the inner cylinder into the outer cylinder. Electrolysis is completed when water in the inner cylinders is completely displaced at a 2:1 ratio (2 parts hydrogen, 1 part oxygen). The cylinder with more gas is the hydrogen cylinder.