

INTELLIGENT FUEL CELL CAR



Westminster College

LABORATORY INSTRUCTIONS

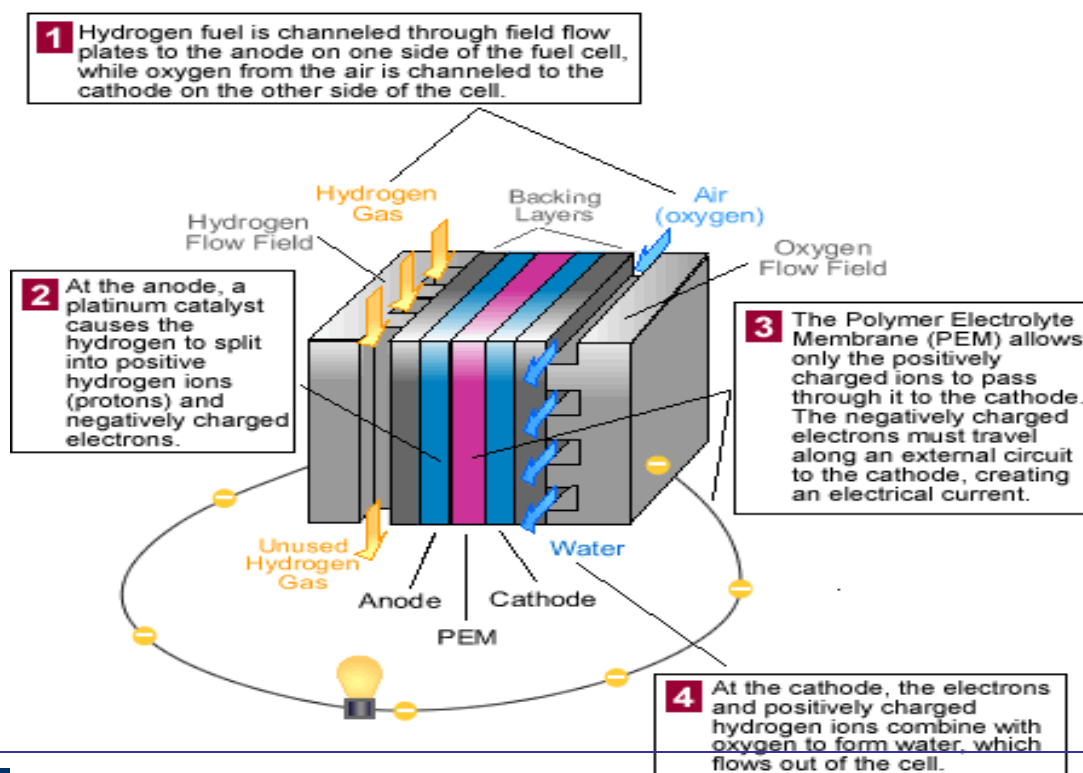
READ ALL INSTRUCTIONS BEFORE USE

The Fuel Cell Car Lab has been developed to provide the safe study of hydrogen fuel cell technology. Special care must be taken to maintain a safe study environment.

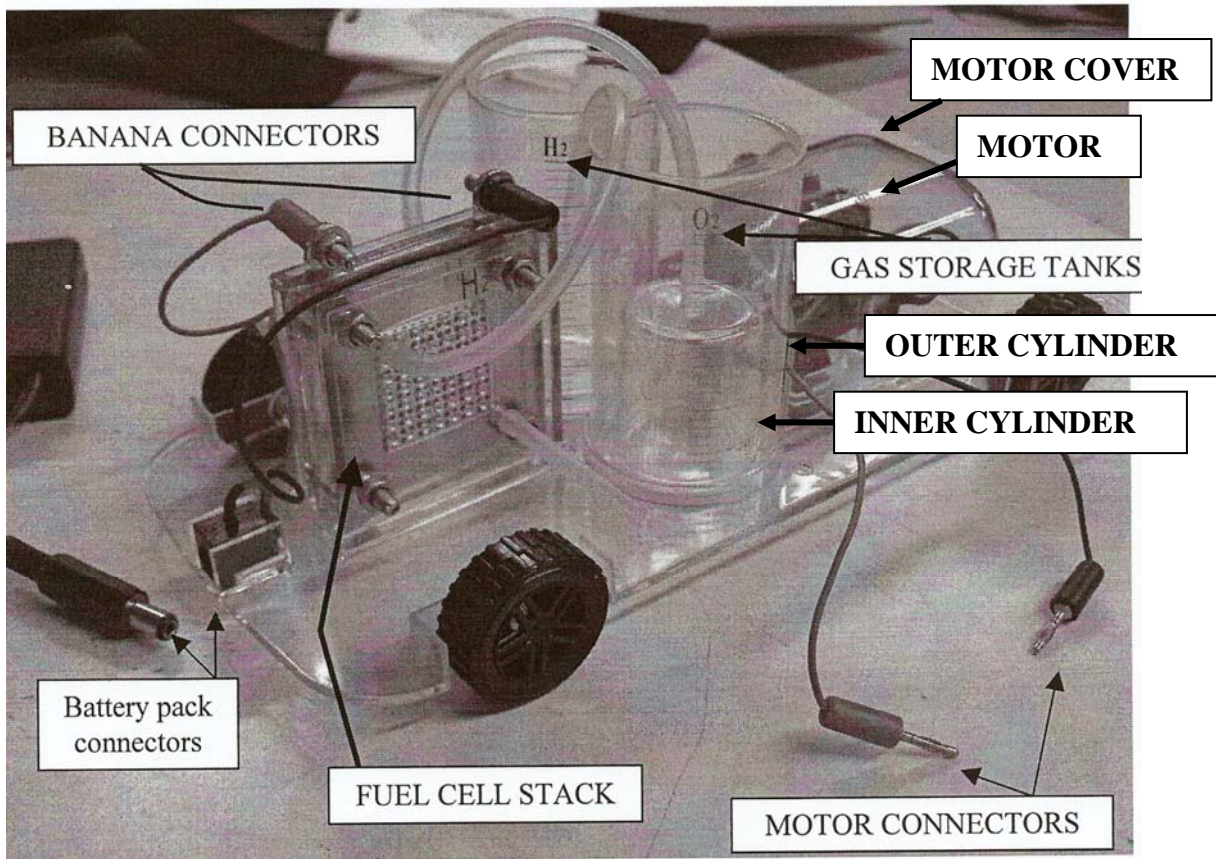
1. Always work with **adult supervision**.
2. **Protect your eyes!** Use safety goggles. Anytime you are performing experiments of any kind, eye protection is important.
3. **Never work around sparks or flames.** Hydrogen and oxygen are extremely flammable. Even though they are contained safely in this kit, it is important to take caution.
4. **Follow instructions.** The instructions in this manual are structured to provide the safest environment for you and to preserve the equipment.
5. **Turn off the battery pack when not in use.** When the battery is turned on, **do not allow the metal leads to touch**, this could cause the battery to overheat resulting in skin burns, plastic melting and fire danger. **Remove the batteries during storage.**

How a PEM Fuel Cell works.

http://www.fueleconomy.gov/feg/fcv_pem.shtml



2-way PEM (Polymer Electrolyte Membrane or Proton Exchange Membrane) Fuel Cell Car



LIST OF PARTS

- | | |
|----------------------|------------------------------|
| A-Motor cover | G-Fuel Cell (.3watts, 350mA) |
| B-Syringe | H-Chassis |
| C-Lower tubes | I-Upper Tubes |
| D-Wheels | J-Inner Cylinders |
| E-Power Supply | K-Outer Cylinders |
| F-Power Supply leads | |

Operating Instructions

Preparation:

100 ml distilled water

(Purified water is NOT the same-it must be Distilled)

Step 1 Remove the back of the battery power pack. Insert two AAA Batteries.

Step 2 Use the syringe to push water into the fuel cell. Fill both sides so that the water is half way up the screen in the chamber.

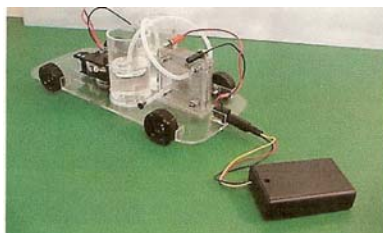
- Unplug the bottom tube of the fuel cell. Insert the syringe into the tube and push in the water.
- You can re-plug the tube, but if you leave the tube open, the fuel cell will run better because droplets of water will be released. *If you do not re-plug the tube, monitor the water level in the fuel cell; water must be in the cell for electrolysis to take place.* This is called purging the fuel cell. Repeat this on the oxygen side of the fuel cell. **DO NOT OVERFILL** the water. The gas needs to be able to climb the screen in the fuel cell to reach the storage cylinder.
- Repeat this process on the other side of the cell.

Step 3 Make sure the hydrogen and oxygen outer storage cylinders are inserted into the round slots on the chassis. Fill the cylinders to the zero mark on each of the cylinders. Insert the inner cylinders into the outer cylinders so the inner cylinders are filled with water. There are two notches at the bottom of each of the inner cylinders. Be sure these are not blocked by the raised plastic frame for the inner cylinders. The opening allows gas to escape the inner cylinder into the outer cylinder for storage

Step 4 Attach the long tube from the top of the hydrogen storage cylinder to the upper nozzle on the hydrogen side of the fuel cell. Repeat this on the oxygen side of the fuel cell. We prefer to put the hydrogen cylinder on the car chassis on the side opposite the hydrogen side of the fuel cell so that the tubes cross, giving the fuel cell and cylinders a little more stability.



Step 5 Attach the plug from the battery pack into the power jack on the back of the car chassis. Insert the red and black wires from the power jack into the red and black banana jacks on the fuel cell.



Step 6 Hydrogen and Oxygen are invisible. You will know gas is being produced when water is displaced to the top of the storage cylinders. You can measure the gas produced by measuring what looks like empty space increasing in the bottom of the cylinders, or by measuring the amount of water displaced to the top of the cylinder.

Step 7 When the hydrogen cylinder is filled, you will begin to see bubbles being released from the top of the hydrogen cylinder. Turn the battery pack off. Unplug the wires from the fuel cell and remove the power jack from the front of the fuel cell.

Step 8 Plug the red and black wires from the car motor to the red and black banana jacks on the fuel cell. Place the car on a flat surface and watch it go! When the car hits a barrier, it will turn 90 degrees and keep moving. Note: You will not have maximum performance until you have used the car three or four times. This is because the PEM membrane becomes better hydrated. You can produce hydrogen and oxygen three or four times before adding additional water to the fuel cell.

If time permits, do steps steps 12 and 13.

Step 12 Use a multimeter to measure the voltage produced by the fuel cell.

Turn the dial on the multimeter to the V section, 20 volts maximum.

Simultaneously touch the multimeter's black wire contact to the fuel cell's black connection and the red wire contact to the fuel cell's red connect. Write down the volts being produced.

_____ volts

Step 13 Use a multimeter to determine how many amps of current are being pushed through the motor by the fuel cell. Turn the control on the multimeter to 200m is A ---. Unplug the red motor wire from the fuel cell; put the red multimeter contact where the red motor wire was connected; hold the black multimeter contact to the red motor wire. Write the milli-amps of current running through the motor.

_____ mA

Intelligent Fuel Cell Car

Tips for Success

1. Your car will run for a longer period of time if it is on a smooth surface. If it is on a rough surface, like a carpet, it has more resistance and will go slower and for a shorter period of time. Also, turning requires a larger amount of energy for the car, so the fewer turns it has to make, the longer will run.
2. In electrolyser mode, make sure you only fill the fuel cell 1/2 full. If it is too full, the hydrogen and oxygen gases do not have the ability to climb the screen to the tube which will transfer the gas to the storage cylinders. If you accidentally fill it too full, continue to run the fuel cell in electrolyser mode until the water is down to 1/2 of the fuel cell and try again.
3. **It is normal** for your fuel cell to have minimal power the first few times you use it. This is because the fuel cell is not well hydrated. Go through the complete cycle of electrolysis/car motor a number of times before you do any initial measurements.
4. Make sure the small outlets on the inner cylinders are not blocked by the plastic rim on the bottom of the outer cylinder. The water uses these small holes to escape to the outer cylinder. Hydrogen and Oxygen are lighter than water, so they flow to the top of the inner tube and the water has to go somewhere. If these small holes are blocked, too much pressure will build in the fuel cell and you can damage the fuel cell.
5. When you run the fuel cell multiple times, water in the upper part of the outer cylinder might not descend to the inner cylinder. This is because a vacuum has been created in the tubing. Disconnect the tubing from the upper nozzle of the fuel cell and the water will descend into the inner cylinder.
6. Use only the power source provided. The power source has a resistor in it that reduces the power of 2 AA Batteries. The fuel cell requires 1.8 volts to work as an electrolyser. However, more than 2 volts going into the fuel cell can damage the membrane. The car will work with more voltage, but you will shorten the life of your fuel cell.
7. It is very important to only use distilled water. Other water includes minerals that will destroy the membrane. If you see brown or orange rust forming in your fuel cell, that means someone did not use distilled water.

QUESTIONS

1. If you were able to make measurements with the multimeter, multiply volts time amps to calculate how many watts of power this fuel cell is providing for the motor:
(note: you will need to divide the number of mA by 1000 to calculate with amps)

_____ volts X _____ amps = _____ watts

2. A single fuel cell of this type produces .85 volts, how many fuel cells like this would be needed to stack together to run a radio that requires 3.40 volts?

(Questions 3, 4, and 5 are multiple choice – circle the letter of the correct answer.)

3. Compared to the oxygen produced in electrolysis, how much hydrogen should be produced?
- The same amount.
 - Half as much hydrogen as oxygen will be made.
 - Twice as much hydrogen as oxygen will be made.
4. What is the source of energy for our electrolysis that generates our hydrogen fuel today?
- The heat in the room.
 - The reaction of chemicals in the batteries we use.
 - Electricity supplied by the power company.
5. Can the fuel cell work to produce electricity if only hydrogen fuel is fed to it?
- Yes H₂ is the fuel – that's all you need.
 - No. The hydrogen must chemically combine with oxygen from a special tank or from the air.