

Name: _____

Class: _____

Date: _____



Physical Sciences

Middle School

5 hours

Objective

Run a hydrogen fuel cell car to explore alternative energy resources and see what factors affect the run time of the car.

Materials

- Horizon's H-Racer 2.0 Kit
- Distilled water
- Stopwatch

Background



Figure 1: The Toyota FCV

The car on your desk might not look like the car in this picture (Figure 1) but they have a lot in common. They're both powered by a high-tech device called a hydrogen fuel cell.

Hydrogen fuel cells can power a car without using gasoline. Instead, it's powered by hydrogen gas. Hydrogen is the most abundant element in the universe, but most of it exists bonded to other elements, so we need to break it apart in order to use it as a fuel. The refueling station takes water (H_2O) and splits it into hydrogen (H) and oxygen (O) atoms. We can then use the hydrogen as fuel in our hydrogen fuel cell car.

The fuel cell takes the hydrogen fuel and combines it with oxygen from the air to produce an electric current that powers the car's motor. Unlike gasoline, which produces harmful pollution as it burns, the only waste product of a hydrogen fuel cell is pure water.

The hydrogen fuel cell car won't always run for the same amount of time because changes in how and where it runs will affect how much fuel it uses as it's running. We'll need to time how long it runs during different trials to see how much energy is being used and how we could make it run for a longer time.

If the energy we put into the car isn't being converted into motion to make the car run, where is it going? How does the hydrogen create energy for the car to use? What kinds of things will affect how long the car will run? Real-life engineers have had to think about these questions and more when designing fuel cell cars and now we'll use our car to do the same.

Method

We will use the Hydrogen Refueling Station to refuel the car multiple times and explore how the car's performance may be altered by conditions of the road surface.

Procedure

As you try out different experiments to increase the efficiency of your car, write down any interesting observations you have in the **Observations** section below.

1. To generate hydrogen, you must attach an electric current to your fuel cell. Use the solar cell or the battery pack to power the fuel cell by connecting the red and black wires to the appropriate sockets on the fuel cell.
2. Observe the car as it's creating hydrogen. How do you know that it's working? What do you *observe* as the fuel cell splits the water inside it?
3. When the cylinders can't hold any more gas, you'll see bubbles start to come up from the bottom. Once this happens, you can disconnect the power source. Your car is now ready to run.
4. Have one group member ready with the stopwatch before you plug in the car's motor. The car will run as soon as you plug it in.
5. Measure how much time the car runs and record it in the data table below.
6. Talk within your group about how you want to change the car to make it run for longer. Do you want to change the weight of the car? How about the surface it runs on? What else could you change?
7. Change one characteristic and repeat the steps to produce more hydrogen and run the car again. Record your data in the table below.
8. Repeat this process for as many different characteristics as you can think of. If you can think of more things to change, record your data on a separate sheet of paper.

Observations:

Write down anything interesting you observe while building or running the car.

Data table

Trial	Time (sec)	How Car Was Changed
1		
2		
3		
4		
5		
6		
7		
8		

Analysis

Make a *scientific claim* about your car: what affected how far or how fast it could go? To help you write a claim statement, see [Stating a Scientific Claim](#).

Claim

What evidence can you use from your observations of the car to back up your claim? State the reasoning you used to make your claim.

Evidence

State the reasoning you used to make your claim.

Reasoning

Use the data you collected to *design an experiment* that you could run to test whether the temperature of the water would affect the speed of the car. Explain the steps of your experiment here:

Use your knowledge of the properties of hydrogen and oxygen to *design an experiment* that you could run to prove that hydrogen and oxygen are the gases produced by the reaction in the fuel cell. Explain the steps of your experiment here:

Conclusion

1. What is the most important change that affected how long the car will run? *Develop an argument* to support your position using evidence you observed during this activity and defend your argument if there are different points of view in your group.

2. Do you think hydrogen fuel cells would make a good fuel source for a full-sized car? *Develop an argument* to support your position using evidence you observed during this activity and defend your argument if there are different points of view in your group.

3. How many ways was energy transformed during this activity? *Construct an explanation* of the different types of energy you observed during this activity and what caused them to transform.

4. Was energy created or used up during this experiment? *Construct an explanation* of where energy was moving during this activity and how you know if it was created or used up.

Measurement

Is the amount of time the car runs related to the amount of electric current it produces? To find out, we'll need to use an ammeter to measure the amount of current being produced by the fuel cell. Read [Measuring Current in a Circuit](#) for more information on how to set this up.

With an ammeter connected to the car, connect the circuit to the fuel cell and start the car. What is the amperage produced?

Car running produces _____ amps.

Using some of the ways you modified the car in the previous section of this activity, try to make the car run for as long and as short as possible. What happens to the amount of electricity produced?

Longer run time produces _____ amps. Shorter run time produces _____ amps.

Make a *scientific claim* about the cause of the differences you observe. What evidence can back up your claim? What is your reasoning?



What if your car didn't carry water to produce hydrogen and instead just carried hydrogen gas. How would that car be different? In the space below, sketch what that car might look like and write an explanation of how it would work.

