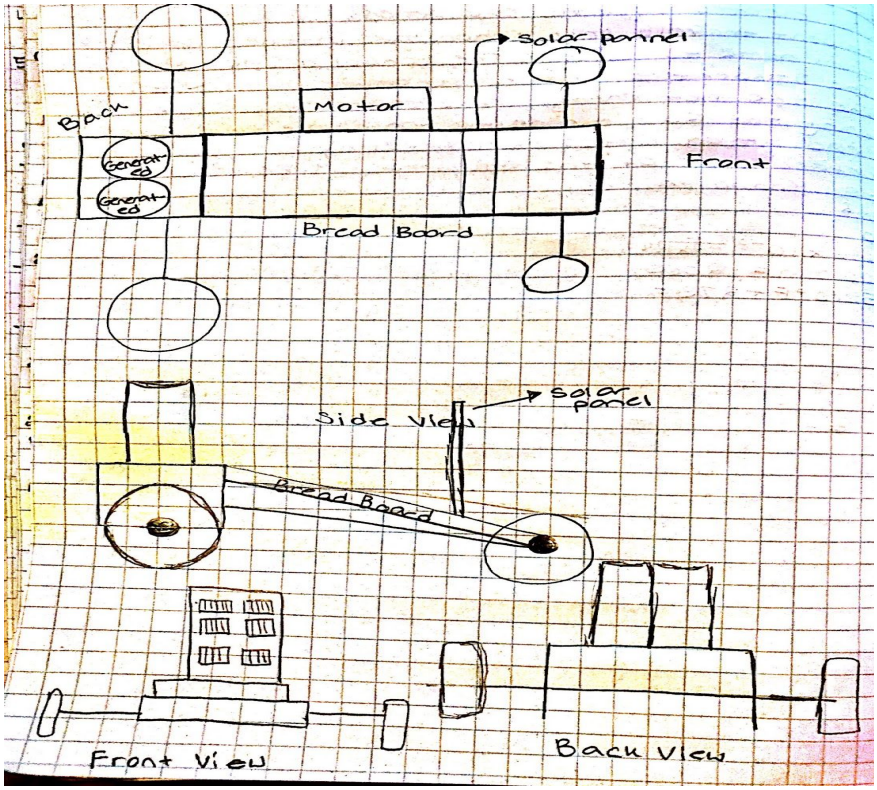
Sydney Brown and Zachary De Guzman
2/20/17
Period 1

Project 1.3.1: Building a Hydrogen Car

Design:

Sketch out ideas before the build. Design should be lightweight and after assembly, carries the motors, solar panel, and hydrogen generator. Design may be based off the one in the lesson, but should still include sketches of the intended design. Notes include changes made during the build phase



Changes:

- We moved the motor from the side to the back. (Later to be attached to the winch system).
- We changed the front wheels from being 2 towards the side to one in the front.
- We added a winch system for speed towards the back which added gears.

Explanation of What the Project is:

- This project used hydrogen (found in the water) to store energy to create electricity to get our car moving. We created a vehicle that used a solar panel, a fuel cell, and a battery to motorize the car. We found that the electricity gathered from the UV rays from the sun through the solar panel heated the breadboard which was connected to the fuel cell that allowed the hydrogen to be filtered to power the car.

What we learned:

- That the Fuel Cell and its use of Hydrogen to power up a system can work out but, can also be inefficient at times. With our experience the hydrogen cell did not move our motor to make our car move but, when given the same amount of energy through a power supply, the motor worked to move the car. The car itself included a winch system unlike most cars. We did this because, it allowed the car to go faster because, the gears were

able to turn the motor quicker. We used a single wheel in the center of our car because, it not allowed more stability but, it allowed better control of the direction of the car. We attached the motor the bigger wheels of the car because, we thought those wheels would have more power to power the motor. Keep in mind this also is what contributed to the speed of our vehicle. The Solar panel on a small scale takes a long time to create enough energy and that was a drawback for us so we used a power supply. The hydrogen cell did not create enough energy and the solar panel took too long to create enough energy. To charge the fuel cell made it inefficient and tedious but, with a revised design of the fuel cell and a better way to transfer energy the car would be more efficient and would greatly reduce energy consumption and lead to a more clean earth.

Build: Documentation explains how work was divided among members of the team
Documentation includes a schematic of your circuit

Work Divided Among Members:

- Sydney- Wheel Assembly, Documentation, the Solar Panel, and Images.
- Zach- Base of car, Bread Board, Hydrogen Fuel Cell, Wiring

Documentation of Calculations:

- Voltage: 1.828 V
- Resistance: .2 Ohms

Voltage: 1.828 VOLTS	Solar Panel Voltage: 2.184	Fuel Cell Voltage: 2.52	Motor Terminal Voltage: 1.37
Current: .2 Amps	Solar Load Current: 2.05	Fuel Cell Current: .4	Motor Terminal Current: .86
TOTAL POWER!!!!: .3656	Solar Load Power: 4.4772	Fuel Cell Power: 1.008	

- We performed this testing by using multimeters, and power supplies. Our testing was a little limited because, we ran out of time finish but, we were able to get the gist of this activity and the testing.

Timeline:

- Monday February 13, 2017: Car Design, Created Ideas for car
- Tuesday February 14, 2017: Building Car (Specifically the wheels and breadboard)

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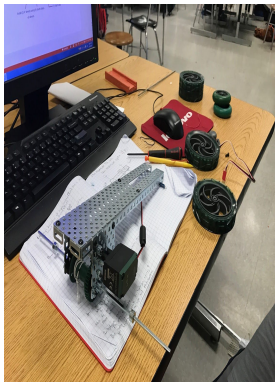
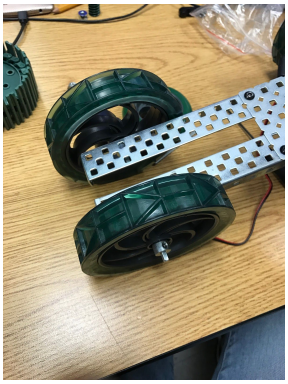
- Wednesday February 15, 2017: Building Car (Specifically attaching the motor and winch)
- Thursday February 16, 2017: Building Car (Specifically wiring with the solar panel and the Hydrogen fuel cell)
- Friday February 17, 2017: Finished Car, Applied Hydrogen Cell, Worked on Wiring
- Saturday February 18, 2017: Project documentation and calculations
- Sunday February 19, 2017: Project documentation and calculations
- Monday February 20,2017: Calculations and Testing
- Tuesday February 21, 2017: Finish Documentation

PICTURES ARE BELOW!!!

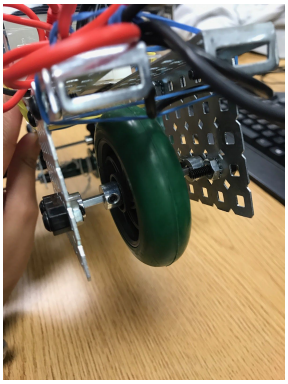


This is when we began our build process. We decided to put or motor in the back but, we were still using the idea of four wheel.

We started the stilts that held up the Hydrogen fuel cell along with attaching the backwheels.



This is the front of our vehicle when we decided to try to level the vehicle by adding the two large wheels to the front as well. We noticed that the wheels were unstable so we came up with a new plan.



We had a little trouble finding a long enough rod to hold both of the large wheels. Therefore, we found another rod and replaced it with a smaller wheel in the center almost like a tricycle. Not only did this allow us to make the vehicle even but, the vehicle became more stable.

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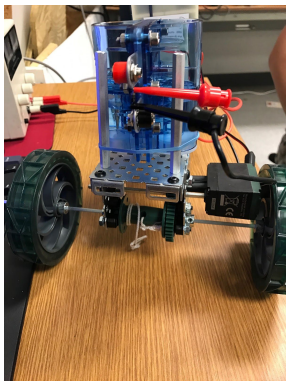
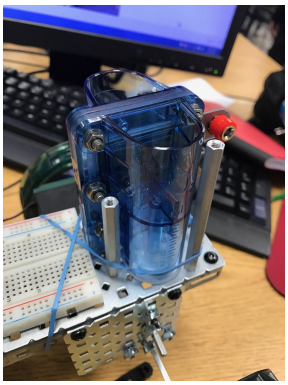
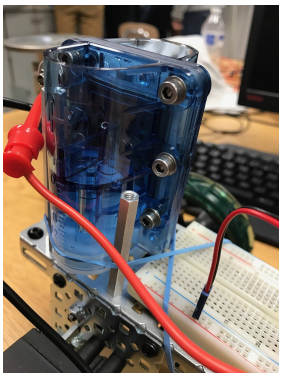


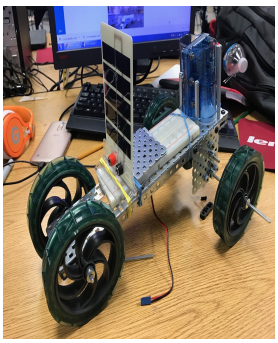
We were charging the fuel cell with a power supply. Also below the charging you can see the winch system that we used attached to the motor. This shows that the motor is directly at the source of energy.



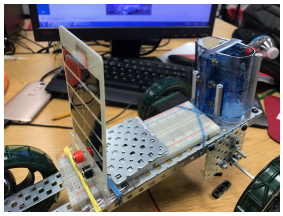
Here we are attaching and fitting the fuel cell for the 1st time using the rubber bands that were provided.



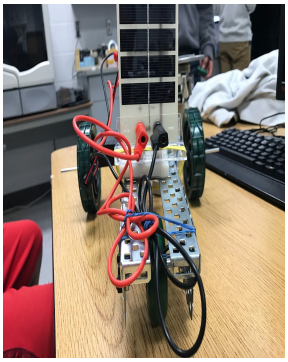
Here we were attaching the wires to the fuel cell and charging it up.



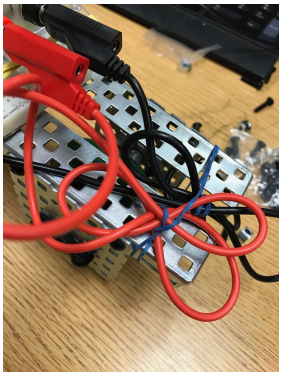
Our first full car build. The front wheels were to heavy for the car. Keep in mind that this image is older and the front wheels have been modified quite a bit.



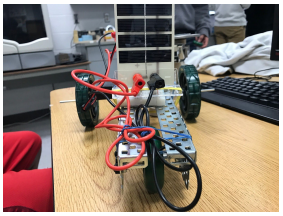
Here is a picture of the full design of the car



Here we modified the design to have one wheel in front to make it lighter and more stable.



Here we just finished all the wiring and securing and organizing the lose wires using the rubber bands provided.



The modified design also helped with the wiring and that they could be tangled on the wheels

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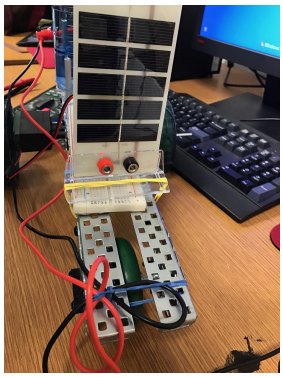
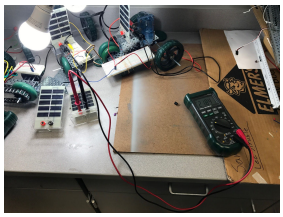
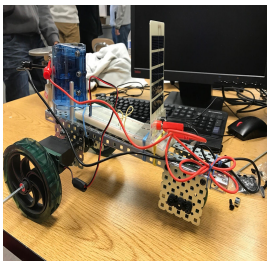
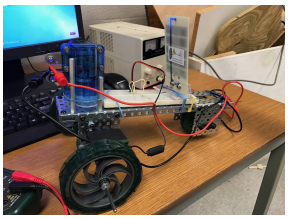
 Here is the solar panel and how we were going to hook it up to the fuel cell	 This is where we charged the solar panel to see how much current and voltage was going through it.	 This is the final build of the car.	 This is our final product of the vehicle. As you can see we tested the voltage and current. We attached all the wires to the multimeters and resistors and found out all of our calculations.

Testing: Table of information including voltage and current generated by solar panel and hydrogen generator. Calculations for how long it takes to charge the hydrogen generator

Documentation of Calculations:

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TOTAL POWER!!!!: ***.3656***	Solar Load Power: ***4.4772***	Fuel Cell Power: 1.008	

- We performed this testing by using multimeters, and power supplies. Our testing was a little limited because, we ran out of time finish but, we were able to get the gist of this activity and the testing.

Analysis: Does the vehicle work. This includes does the drive system work, and does it provide enough energy to move the vehicle

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- Yes the vehicle does work. The winch system that we included in the back of the vehicle provided a lot of speed which made our vehicle a lot faster than others. By using the one wheel in the center of the vehicle it allowed our vehicle to have sustainability. The drive system does work and we have tested it. Yes it does provide enough energy to move the vehicle.

Timeline:
Tuesday - Introduction of project. Should have design sketches finished by the end of class and building has started
Wednesday - Build Phase. Majority of build should be finished by end of class
Thursday - Finish build and testing should be mostly finished.
Friday - Final testing of vehicles. Group documentation due by Midnight

Rubric

Documentation	**Explaination of what this project is, and what has been learned**	Explaination of what this project is	No introduction of what this project is, or what has been learned
Sketches	**Sketches are well drawn with good line quality and proportional. Clearly lays out the power train and structure**	Sketch is quickly drawn with moderate line quality, but drawings are still clearly displaying the power train and structure	Poorly drawn sketches that do not fully show drivetrain or structure
Teamwork	**Documentation explains division of work among team members, including timeline**	Documentation explains division of work, but no timeline of completion	No mention of how the team worked together
Build documentation	**Images and text explain the build process, including**	Partial explanation of how it was built (text and images)	Little to no documentation of the build. IE: Images but

	any design changes		now text
Component testing	**Tables fully document solar panel measurements and hydrogen generator, explain how testing was performed and conditions**	Testing of hydrogen generator or solar panels, little explanation of how it was tested or the testing conditions	Partial tables and limited calculations. No explanation of how it was tested
Build results	**Final build matches the final design, including any documented design changes**	Final build closely matches original design, but does design changes not documented	Build does not match the original plans
Final testing under hydrogen power	**Vehicle runs and is able to move itself (with or without starting assistance)**	Vehicle runs, but cannot move itself	Vehicle does not run

Activity Portion

3. Shine a bright light source on the solar panel, always keeping at least 8 inches of separation between the two to avoid melting the solar module plastic. Set your multimeter to measure voltage and connect the multimeter test leads to the solar panel terminals. Move the solar panel or light source to determine the location that produces the highest voltage value. You may want to mark the positions with some tape. Record the open-circuit voltage. Note the current is zero, since a voltmeter has nearly infinite resistance.

VOC = Open-Circuit Voltage ***1.828***

Power = VOC x 0 A = 0 W

4.With the test leads disconnected, set your multimeter to measure current. Return the solar module to the same exact position that produced the highest voltage value and measure the current. Record this short-circuit current. Note that the voltage is zero, since an ammeter has nearly zero resistance.

ISC = Short-Circuit Current ***.2 Amps***

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Power = 0 V x ISC = 0 W

Power = Voltage x Current, but they have to be occurring at the same time!

5. Calculate the amount of power that would be produced by the solar module if it could simultaneously produce the voltage and current you measured in the previous two steps. For this illumination level, the solar module will deliver, at most, about 70% of this theoretical maximum, and will do so at a resistance between zero and infinite resistance.

Maximum Theoretical Power = VOC x ISC

*= **.3656***

6. Attach the solar panel to the solar hydrogen automobile. Using a standoff or another suitable method, prop up one end of the chassis so that the motor-driven wheel is not in contact with the ground. Connect the motor leads to the solar module using the breadboard to make the connections. Position the light source to produce maximum voltage leaving a minimum distance of 8 inches between solar module and the lamp. Is there enough power to turn the motor? If so, is there enough power to turn the motor with the wheels on the ground? **No**

7. Set your multimeter to measure voltage. Connect the multimeter test leads to the solar module terminals. Record the load voltage value.(Drive gear should be engaged).

*V = Load Voltage **2.184***

8. Disconnect the test leads and set your multimeter to measure current. Connect the multimeter in series with the solar module. Record the load current.

*I = Load Current = **2.05***

9. Calculate the power delivered by the solar module when it is loaded by the motor with the wheels off the ground.

*P = Load Power = I V = **4.4772** for solar module.*

10. Energize the fuel cell by using one of the power sources according to the directions in the Fuel Cell User Guide under the section “Powering the Fuel Cell (Electrolysis)”.

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Fuel cells can be damaged by high current. If using a DC power supply with the Heliocentris fuel cell, do not use more than 500 mA. Do not use a battery to energize the fuel cell.

11. After the fuel cell is energized, attach the fuel cell to the motor using the breadboard to make the connections. Is there enough power to turn the motor? If so, is there enough power to turn the motor with the wheels on the ground? **No**

12. With the test leads disconnected, set the multimeter to measure voltage. Connect the multimeter test leads to the fuel cell terminals. Record the voltage value.

*V = Load Voltage **2.52***

13. With the test leads disconnected, set the multimeter to measure 10 A current, using the 10 A meter receptacle. Connect the test leads in series with the fuel cell.

Caution! Never measure current from the fuel cell without a resistor, motor, or other load in series with the ammeter. Doing so can permanently damage the fuel cell.

Record the current value.

*Load Current = **.4***

14. Calculate the power delivered by the fuel cell. Power = Voltage x Current.

*P = Load Power = I V = **1.008** for fuel cell.*

15. Remove the fuel cell and solar module and attach the two AAA battery holders to your vehicle using zip ties. Using the breadboard, connect the batteries in series with each other and with the motor. (See next step for wiring hints.) Is there enough power to turn the motor? If so, is there enough power to turn the motor with the wheels on the ground? **Yes (Used Power Supply)**

16. With the test leads disconnected, set the multimeter to measure voltage. Connect the multimeter test leads to the motor terminals. Record the voltage value.

*V = Load Voltage **1.37***

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17. With the test leads disconnected, set the multimeter to measure 10 A current, using the 10 A meter receptacle. Connect the test leads in series with the motor terminals. Record the current value.

Load Current = ***.86***

(Don't have batteries)

18. Calculate the power delivered by the batteries in series.

P = Load Power = I V = for batteries in series

19. Using the breadboard, connect the batteries in parallel with each other and with the motor. Is there enough power to turn the motor? If so, is there enough power to turn the motor with the wheels on the ground?

20. With the test leads disconnected, set the multimeter to measure voltage. Connect the multimeter test leads to the motor terminals. Record the voltage value.

V = Load Voltage

21. With the test leads disconnected, set the multimeter to measure 10 A current, using the 10 A meter receptacle. Connect the test leads in series with the motor terminals. Record the current value.

Load Current =

22. Calculate the power delivered by the batteries in parallel.

P = Load Power = I V =_____ for batteries in parallel

Conclusion Questions

1. Using the measurements you made, compare and relate the four options you explored. Was the car best powered by a single fuel cell, a single solar module, two AAA batteries in series, or two AAA batteries in parallel?

2. Did voltage, current, or power best describe the suitability of a power source?

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3. If you had many solar modules, how many of them would be needed to get the same performance from the car as the performance observed with two AAA batteries? Describe or sketch how you would connect the solar modules in terms of parallel and series circuits.

4. If you had many fuel cells, how many of them would be needed to get the same performance from the car as the performance observed with two AAA batteries? Describe or sketch how you would connect the fuel cells in terms of parallel and series circuits.

5. Describe and defend a system that you believe would best utilize a solar hydrogen system to meet the needs for an average driver.

6. How does a photovoltaic cell work? Record the source of your information.

7. Detail how electrolysis separates hydrogen and oxygen. How is electricity produced as the fuel cell allows the hydrogen to reunite in a bond with oxygen? Record the source of your information.