Renewable Energy Endurance Marathon

Goals

- ✓ Assemble multiple cars powered by renewable energy
- ✓ Alter the cars to increase their range
- ✓ Compare the pros and cons of different technologies

Background

One of the biggest challenges to building a car powered by renewable energy is the issue of range. People have always had to refuel their cars to keep them moving, but it's something that no one wants to have to do every day or every couple of hours on a long trip, so cars need to have the ability to travel for hundreds of miles at a time.

Also, no one wants to buy a car that takes forever to refuel. Electric cars especially have suffered from this drawback: it takes more than half an hour to fully charge their batteries on a high-speed charging system, and many hours to do so on a regular household electric current.

There are many different options for powering cars with renewable energy, but range will always be a factor in most people's decision on whether or not to buy a particular car. So whatever the fuel of the future might be, cars that run on it will have to be able to run for a long time.

Here are some examples of technologies that could be used to power cars and how they work:

- Solar panels – Change light to electricity to power an electric motor.
- Supercapacitors – Store electricity in a capacitor to power an electric motor.
- Fuel cells – Use hydrogen, split from oxygen in water, to generate an electric current and power a motor.
- Batteries – Store electricity chemically and use it to power an electric motor.
- Metal hydrides – Store hydrogen chemically and use it in a fuel cell to power an electric motor.

You may notice that many of these technologies seem very similar. At some point, they all have to turn a motor in order to get the car to move. However, the way in which they get the energy to do so is very different, and can result in a big difference in the amount of time that they can run.

During this activity, we will build cars powered by different technologies, modify them to try to increase their range, and determine which type of car can keep running for the longest time.

Note: For each trial, have one member of your group stand at either end of the race track. Release the car from one end and have the person at the other end pick up the car and turn it around once it reaches them. Continue to do this until the car stops running and record your time and distance.

Solar Car Procedure

1. You'll need the car frame, red and black wires, the solar panel, and the solar panel support to assemble the solar car.
2. Look at the top of the car frame to see where you should attach the solar panel support. Make sure the solar panel support fits securely onto the top of the frame.

Renewable Energy Endurance Marathon

3. Place the solar panel on top of the support.
4. Connect the wires from the motor to the red and black plugs nearest to them on the front of the frame.
5. Use the other red and black wires to connect the solar panel to the other plugs on the front of the frame.
6. Make sure the car is in direct sunlight, and it should start to run.
7. Use the stopwatch to time how long your car travels. Calculate distance by counting laps and multiplying by 5, then add on however many more meters your car traveled on its final lap. Repeat and record your results in the table below.

Trial	Time (sec):	Laps:	Distance (m):	Observations:
1				
2				
3				

Fuel Cell Procedure

1. You'll need red and black wires, the fuel cell, battery pack, H2 and O2 cylinders, two lengths of tubing, and a syringe to assemble the fuel cell.
2. Insert the cylinders into the frame of the car. Fill them with about 40 mL of distilled water.
3. Uncap the tube on the O2 side of the fuel cell.
4. Fill the syringe with distilled water and fill the fuel cell using the syringe.
5. Replace the cap on the O2 tube.
6. Insert the fuel cell into the frame of the car in front of the cylinders. Attach the H2 and O2 sides of the fuel cell to the H2 and O2 cylinders with the longer tubes, which will prevent the hydrogen and oxygen gases from escaping.
7. Connect the battery pack to the fuel cell using the red and black plugs, then turn on the battery pack. You should see the fuel cell start to generate hydrogen and oxygen gas.
8. Once you see bubbles start to escape the H2 cylinder, turn off and disconnect the battery pack.
9. Connect the loose red and black wires to the fan or LEDs to start generating electricity.
10. Use the stopwatch to time how long your car travels. Calculate distance by counting laps and multiplying by 5, then add on however many more meters your car traveled on its final lap. Repeat and record your results in the table below.

Renewable Energy Endurance Marathon

Trial	Time (sec):	Observations:
1		
2		
3		

Salt Water Battery Procedure

1. You'll need red and black wires, the salt water battery (white bottom and blue top), syringe, and a graduated cylinder to assemble the salt water battery.
2. Get salt water solution from your teacher and put it in the graduated cylinder. Make sure to get at least 25mL. And be careful, it's hot!
3. Using the syringe, transfer 15mL of the salt water solution into the bottom of your battery.
4. Snap the blue top of the battery onto the white bottom.
5. Attach one red wire to two red plugs on the left and right sides of the battery at the back.
6. Connect the wires from the motor to the red and black plugs nearest to them on the front of the frame.
7. Connect the loose wires from the battery to the other plugs on the front of the frame.
8. Use the stopwatch to time how long your car travels. Calculate distance by counting laps and multiplying by 5, then add on however many more meters your car traveled on its final lap. Repeat and record your results in the table below.
9. When you're finished with the salt water battery, rinse the top and bottom with distilled water.

Trial	Time (sec):	Observations:
1		
2		
3		

Supercapacitor Procedure

1. You'll need red and black wires, the capacitor, and the hand-crank generator to use the supercapacitor.
2. Connect the capacitor to the hand-crank generator using the set of red and black wires.
3. Gently turn the hand-crank clockwise to generate current and charge the capacitor. Charge the capacitor for at least 60 seconds.
4. Disconnect the hand-crank generator from the capacitor and connect the capacitor to the plugs on the front of the frame. Secure the capacitor in the middle of the frame.

Renewable Energy Endurance Marathon

5. Connect the wires from the motor to the red and black plugs nearest to them on the front of the frame.
6. Use the stopwatch to time how long your car travels. Calculate distance by counting laps and multiplying by 5, then add on however many more meters your car traveled on its final lap. Repeat and record your results in the table below.

Trial	Time (sec):	Observations:
1		
2		
3		

Renewable Energy Endurance Marathon

Experimentation

1. Choose two or three technologies that traveled the farthest. Discuss with your group ways you could improve the car to make each of them go even farther. Write down your best ideas here:

Light Color:	Observations:
	1. 2. 3.
	1. 2. 3.
	1. 2. 3.

2. Now build your car using each technology and try the ideas you thought of to see what happens to the car's speed. Record what you changed, how you changed it, and the results below:

Technology:	Changed What?:	Changed How?:	Time (sec):	Distance (m):

Renewable Energy Endurance Marathon

Analysis

1. Make a scientific claim about what you observed while racing your cars.

2. What evidence do you have to back up your scientific claim?

3. What reasoning did you use to support your claim?

4. Design an experiment that would test whether the surface the car runs on affects its range. Describe your experiment below:

Renewable Energy Endurance Marathon

Conclusions

1. What would be the biggest drawback to using the technology that ran for the longest time in a full-sized car? What makes this problem the biggest drawback?

2. What is a possible way that you could overcome this drawback?

3. Do you think the technology that ran for the longest time would be the most practical solution for a renewable energy source to power a full-sized car? Why or why not?

4. Could a combination of these technologies perform with even better range? Describe a possible combination below that you think might work.