

# 2004 National Hydrogen Fuel Cell Model Car Challenge

## Rules and Guidelines

### Objective

The objective of the Hydrogen Fuel Cell Model Car competition is to use the materials provided to design and build a Hydrogen Fuel Cell Model Car on site.

**The Hydrogen Fuel Cell Model Car Competition will have two separate competitions. Teams will choose either the Speed Race OR the Hill Climb competition.**

- 1) **SPEED RACE:** To build a vehicle that will complete a 20 meter straight and horizontal race in the shortest possible time using the energy provided by the hydrogen as its only means of propulsion.
- 2) **HILL CLIMB:** To design a car that will be able to climb the steepest incline track and move from the starting line to the finish line (about 6 feet) in 120 seconds or less.

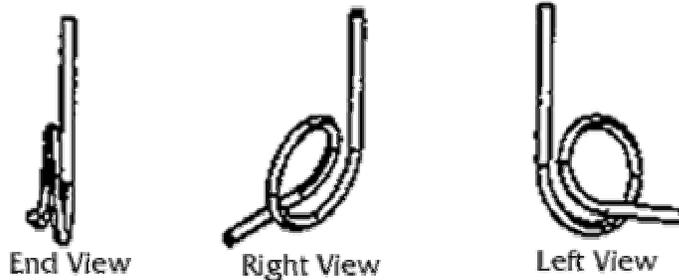
Teams will construct their hydrogen fuel cell cars onsite using a kit. Only the gas tank and fuel cell from the original kit will be used. Other materials and supplies will be provided to each team to build their fuel cell car. Materials include: gas storage collector (clear plastic container), motors, various types of wheels, two axles, various gears, 6 alligator clips, electrical connection wires, and different chassis bodies such as balsa wood or foam core. All hand and power tools will be supplied at the competition site. Using only the materials provided, competitors will build a fuel cell powered vehicle. Teams **cannot** bring a pre-constructed fuel cell car, plans, drawings, or any additional car parts or components to the competition.

### Materials

- 1) The wheels, axles, electric motor, gears, electrical connection wires, and a basic body frame may be modified at the discretion of the team.
- 2) The remainder of the vehicle must be the team's design and can be made from any other materials provided in the team materials box.

## Vehicle Specifications

- 1) The vehicle must be safe for contestants and spectators (e.g., no sharp edges, projectiles, etc.).
- 2) The vehicle cannot exceed the following dimensions: 30 centimeters x 60 centimeters x 30 centimeters.
- 3) Decals of sponsoring organizations (provided by Science Bowl Central) must be visible on the side of the car's body. A space of 1 inch x 1 inch must also be available on the side of the car where an assigned vehicle number can be placed.
- 4) Energy Source: The electrolysis to charge the gas tanks will be completed in a designated charging area prior to the start of the race. The only energy source permitted on the vehicle is the fuel cell with the hydrogen that was produced from the electrolysis procedure.
- 5) Steering (for the Speed Race Only): An eyelet must be attached to the bottom front of the car. An example of a possible design is illustrated below. A guide wire, 1 cm. (+/- .05 cm) from the surface of the track, will go through the attached eyelets on the car, serving as the steering mechanism, and keeping the car in its lane. The vehicle must be easily removed from the guide wire, without disconnecting the guide wire. This is the only allowable method of steering the car. Lane changing or crossing will result in disqualification.



- 6) Glue the eyelet to the bottom of your car near the front (or use two eyelets--one near the front and one near the rear). The guide wire will pass through the eyelet to keep your car in its lane.
- 7) All vehicles will be inspected by a race official prior to the beginning of the race to ensure that they meet the above vehicle specifications (see inspection checklist). Vehicles that meet these requirements will be given a green sticker that will be placed on the vehicle. Vehicles that do not meet these specifications may be modified and re-inspected. All vehicles that participate in the race events must have a green sticker. Race officials may re-inspect the vehicles at any time during the race and remove the green sticker if a vehicle has been modified in a way that it fails to meet the vehicle specifications.

## SPEED RACE

### Track Specifications

- 1) The length of the race course is 20 meters over level terrain.
- 2) Racing lanes must be at least 60 centimeters wide.
- 3) A guide wire will be located in the center of each lane of the track and will not be more than 1.5 cm above the track surface.
- 4) The track will be a hard, smooth, level surface such as the basketball court at the 4-H center in Washington, DC. A large sheet of rolled material (e.g., plastic, heavy paper, roll roofing [half-lap], or hardwood taped or bolted together) may be used to cover an uneven surface.

### Conduct of the Race

- 1) **Charging Station:** The fuel cell must be charged at the charging station using a provided energy source, such as a 9-volt battery, a DC power supply, or a solar panel.
- 2) **Race Day Electrolysis Procedure:** Before the scheduled race start, all teams must report to the designated charging station with their fuel cell car and solar cell. Distilled water will be provided at the charging station for the electrolysis process. There is no time limit on the electrolysis procedure—a team may report to the charging station as early or late as necessary; however, teams must be ready to start their race at the specified time. The only energy source permitted on the vehicle is the fuel cell with the hydrogen that it produced from the electrolysis procedure.
- 3) The speed race competition is made up of eight competing teams. Heats will be run as a series of double elimination rounds. For example, four teams will race in the first heat. The top two winning teams will advance to the winner's bracket and the two losing teams will advance to the challenger's bracket. Any team losing two races is eliminated.
- 4) At race time, vehicles will be placed behind the starting line with all wheels in contact with the ground.
- 5) At the start of the race, the student at the starting line will connect the leads of the fuel cell to the electric motor. The student must lift the drive wheels off the race course until the signal has been given to start the race.
- 6) An early or push start will result in disqualification or re-running the race. The race officials will determine if a student is disqualified or if the race must be rerun.
- 7) The race will start when the official signal is given. At the signal the drive wheels will be placed in contact with the race course and the car released. The vehicle to cross the finish line first or is the furthest down the track is the winner.
- 8) One member of each team must wait at the finish line to catch the vehicle.

- 9) Team members may not accompany or touch the vehicle while it is racing on the track. Vehicles stalled on the track may be retrieved after the end of the race has been declared.
- 10) Vehicles and team members must remain at the finish line until the winning order of the race has been established.
- 11) Vehicles that change or cross lanes will be disqualified (at the discretion of the race officials).
- 12) All decisions of the race officials are final.
- 13) Officials have the option to inspect cars prior to the final heat or at any time during/after the heats are completed.

### **Awards**

Three fastest teams will receive trophies and cash prizes.

## HILL CLIMB

### Track Specifications

- 1) The length of the hill climb course is 6 feet long and will accommodate 4 cars racing at the same time.
- 2) The track will be set on the ground or a very low table which will accommodate having a student at the starting line and a student at the finish line.
- 3) Racing lanes must be at least 30 centimeters wide.
- 4) The track will be a hard, smooth, level surface.
- 5) The track will have a designation for both the start and finish line.
- 6) The track will have uprights on either side that will facilitate the raising and lowering of the track to predetermined incline angles.
- 7) There will be a 1 inch edge built on the start and finish ends of the track. Cars will rest on the edge at the start of the race.



### Conduct of the Race

- 1) The hill climb competition is made up of eight competing teams. Heats will be run as a series of increasing steeper inclines and single elimination rounds. The teams that finish the race at a particular angle will advance to the next designated incline and the cars that fail to cross the finish line will be eliminated.
- 2) In the final heat, if no car crosses the finish line then the car that is farthest up the incline will be declared the winner.
- 3) At race time, vehicles will be placed behind the starting line with all wheels in contact with the ground.
- 4) The starting line will be marked. This will allow all cars to start at the same spot.
- 5) An early or push start will result in disqualification or re-running the race. The race officials will determine if a student is disqualified or if the race must be rerun.
- 6) The race will start when the official signal is given. All cars that cross the finish line will advance to the next designated incline.
- 7) One member of each team must wait at the finish line to catch the vehicle.
- 8) Team members may not touch the car while it is climbing up the track. Vehicles stalled on the track may be retrieved after the end of the race has been declared.

- 9) Vehicles and team members must remain in the race area until the winning cars have been established.
- 10) All decisions of the race officials are final.
- 11) Officials have the option to inspect cars prior to the final heat or at any time during/after the heats are completed.

### **Race Procedures**

- 1) All eight cars will start at some initial incline.
- 2) Cars that succeed at the initial incline will move on to future heats with successively steeper inclines.
- 3) The winning car will be the car that crosses the finish line at the steepest incline.
- 4) In the final heat, if no car crosses the finish line then the car that is farthest up the steepest incline will be declared the winner.

### **Awards**

Top three teams that cross the finish line at the highest inclines will receive trophies and cash awards.

## RACE PROCEDURES AND OFFICIAL'S ROLES

It is important that the officials know the procedures thoroughly. The Race Officials need to understand the steps of the race and their roles in enforcing the track rules. The steps of the race are listed below, followed by more specifics and dispute information.

### STAGE

- The Master of Ceremony's will call for a heat to "STAGE".

**Charging Station:** Electricity needed for the electrolysis procedure will be provided at the charging station.

**Race Day Electrolysis Procedure:** Before the start of the scheduled race, all teams must report to the designated charging station with their fuel cell. Distilled water will be provided at the charging station for the electrolysis process. There is no time limit on the electrolysis procedure—a team may report to the charging station as early or late as practical; however, teams must be ready to start their race at the specified time. The only energy source permitted on the vehicle is the fuel cell with the hydrogen that it produces from the electrolysis procedure.

1. The students will bring their cars to the start (up to two students at the start)
2. One student will stand at the track finish line to catch the car
3. The Lead Official and the Start Official will check the heat cards to make sure that the right team is on the right lane
4. The Start Official will check each car at the start line for:
  - green inspection sticker
  - car number
5. The Lead Official will indicate any "no shows" on the Heat Card.
6. The Lead Official will hand out the Heat Cards to the Finish Line Officials.

### START

1. All spectators will be moved back and the announcement will be made that the heat is about to start.
2. There are two officials assigned to each lane, a Start Official and a Finish Official. [Speed Race Only]
3. All students will set their cars behind the start line. They must keep the fuel cell disconnected from the electric motor until the "Ready Car" signal is given by the Start Official.
4. The Start Official will signal "Ready Car" to the teams. The racing teams then lift the drive wheels from the track and connect the leads from the fuel cell to the electric motor.
5. The Lead Official will signal the start. The students will then place the drive wheels on the track and the race begins.

If a student places the wheels on the track before the “starting-signal” is sounded, the Start Official indicates a false start and the race will be rerun or the early starter may be disqualified at the Start Officials’ discretion. [Speed Race Only]

## **RACE**

1. Students that are racing cars are not to leave their position at the start or end of the track during the race. Even if their car has become hung up on the guide wire or has stopped during the race. Start Officials may direct a student to retrieve his/her car along the track and disengage the car from the guide wire.
2. No Officials should be distracted. They are required to watch every heat thoroughly. ANYONE interfering with an Official or the Official’s eye contact with the track should be told by the Official to leave or stand back during the race.

## **FINISH**

1. At the end of each heat the Finish Officials will agree on the winner(s). The winner and loser are indicated on the Heat Cards and are turned over to the Runners.
2. The Lead Official will acknowledge the winner(s), so as to avoid disputes later.
3. The Finish Officials will give the Heat Cards to the designated “Runners” to take to the Scorekeeper.
4. The Start Officials will begin staging for the next heat.

## **TRACK OFFICIALS**

1. Track officials are the track and race guards.
2. The role of the track official is to keep all people off the track and outside designated areas. The guide wire is made of clear fishing line and is very difficult to see.
3. Only students competing in a heat should be at the track’s start and finish.
4. One student releases the car to start and one student catches the car at the finish. There is soft material at the finish so if the cars get past the student at the finish line, it will NOT crash into the cinder block or end piece.
5. Do not let the students take the cars from the finish line until the Lead Official indicates that the winners have been noted on the Heat Cards.
6. Make sure that you have a clear visual perspective of the entire race to ensure fairness.
7. No one should be between the tracks at any time. The only exception to this will be the Officials or an official event Photographer or Videographer who will not interfere with the race and the official’s view of all lanes.
8. If a car gets hung up on the guide wire, the Start Official may grant permission for the student to unhook the car from the guide wire.

## **LEAD OFFICIAL**

The Lead Official is THE person responsible for controlling the race competition. It is important that you are familiar with the hydrogen fuel cell model car race and all of the competition rules. It is, therefore, extremely important that you review the rules well in advance of the actual event.

The hydrogen fuel cell model car competition is a hands-on science competition in which student teams design, build and race model fuel cell model cars. The hydrogen fuel cell model car competition has two different competitions: single elimination hill climb and a double elimination speed race competition.

1. The Master of Ceremony will announce each heat by reading the team names and assigned lanes. The Lead Official collects the team Heat Cards at the start of each race and verifies with the Start Officials that each team is present and in the assigned lanes.
2. If a team is not ready to start the race, the Lead Official will announce the team name one more time. Consideration will be given by the Lead Official and Inspection Official if the car is being repaired and misses the designated heat.
3. The Lead Official will hand the Heat Cards to the Finish Officials for completion.
4. The Lead Official and Race Officials will make sure that the spectators are not blocking the lanes.
5. The Lead Official will announce the start of the race and will verify with the Start Officials that the students have their cars hooked to the guide wire and the fuel cell leads attached to the motor.
6. The Lead Official will start the race by signaling.
7. Students will lower the drive wheels to the track to begin racing their cars. The Lead Official will acknowledge the winners. If a car is hooked to the guide wire or the car has stopped during the race, the Starting Official will give permission to the student to go and unhook their car from the guide wire after the Lead Official has announced the winners.

## **START OFFICIAL**

Your duties as a Start Official include:

1. Ensuring all competition rules are followed. To serve in this capacity, it is imperative that you fully understand all competition rules. Please review the competition rules before coming to the hydrogen fuel cell model car competition training session.
2. The Start Official reviews the Heat Card to make sure that the right car is in the right lane.
3. The Start Official makes sure that the car number and inspection sticker are on the car.
4. The Start Official assists the student in hooking the car to the guide wire.
5. The Start Official makes sure that the student has the fuel cell disconnected from the electric motor prior to the start of the race.
6. Move any spectators back from the racing lanes.
7. Make sure that your line of vision is not blocked.

8. Once the Lead Official calls for the start of the race, indicate to the Lead Official that your lane is ready to start the race.
9. The Start Official gives the "Ready Car" signal and the students connect the fuel cell to the electric motor.
10. If a student places the car on the track and releases it prior to the start signal, yell out FALSE START so the heat can be rerun.
11. Once the Lead Official has announced the winner of the heat, if the student's car got hung up on the guide wire or has stopped in the middle of the track, you can give the student permission to go and unhook the car from the guide wire.
12. If there are disputes to a race, you might be consulted by the Rules Committee to make a final decision.

## **FINISH OFFICIAL**

Your duties as a Finish Official include:

1. Ensuring all competition rules are followed. To serve in this capacity, it is imperative that you fully understand all competition rules. Please review the competition rules before coming to the hydrogen fuel cell model car competition training session.
2. Prior to the start of the race, the Finish Official takes the Heat Card from the Lead Official for their appropriate lane.
3. Move any spectators back from the racing lanes.
4. Make sure that your line of vision is not blocked.
5. The Finish Official ensures that there is a student ready to catch the car after it passes the finish line.
6. Once the Lead Official calls for the start of the race, indicate to the Lead Official that your lane is ready to start the race.
7. Watch the race carefully and indicate to the other Finish Officials if the car in your lane is in first place.
8. Note the placement (win or lose) on the Heat Card.
9. Inform the Lead Official so he/she can announce the winner of the heat.
10. If there is a dispute among the Finish Officials about the placement of the cars, review the video camera footage of the race (if available) to determine the winner.
11. The Finish Officials will hand the completed Heat Cards to the Runners who will take the Heat Cards to the Scorekeeper.
12. If there are disputes to a race, you might be consulted by the Rules Committee to make a final decision.

## **SCOREKEEPER**

Your duty as a Scorekeeper is to:

1. Have the teams randomly select numbers to assign them in the initial heats.
2. Complete the Heat Cards with the first heat number and lane assignments.
3. Fill in the scoreboard with the initial heat information.
4. Give the completed Heat Cards to the Master of Ceremonies to distribute to the teams.

5. Make copies of the Heat Assignments for the Master of Ceremonies to announce the next heats.
6. Once the heats are run, the Runners will hand the completed Heat Cards to you for recording.
7. Assign the next heat assignments and hand the newly updated Heat Cards to the Master of Ceremonies to distribute to the teams.
8. Accurately record the competition results. Scores will be recorded on a scoreboard, which should be visible to all competitors and Hydrogen Fuel Cell Model Car officials.
9. After teams have been double eliminated, keep the Heat Card.
10. After the races are complete, provide the Master of Ceremonies a list of the teams and team members for the first, second and third place teams

## **HYDROGEN FUEL CELL MODEL CAR-SCIENCE BOWL CENTRAL**

The Hydrogen Fuel Cell Model Car *Science Bowl Central* is designed to provide a central location for information prior to and between races. Officials/volunteers and teams check here to receive information and heat assignments.

The Hydrogen Fuel Cell Model Car *Science Bowl Central* should be staffed by at least two individuals throughout the course of the event. Their responsibilities include answering questions pertaining to the races, race times, advancement of teams, etc.

### Primary Responsibilities:

Assist the Scorekeeper to update the Hydrogen Fuel Cell Model Car Competition scoreboards.

Answer questions from spectators and assist in crowd control.

Items that should be available at Hydrogen Fuel Cell Model Car *Science Bowl Central*:

- Paper
- Pencils
- Magic Markers
- Extra Stopwatches, if possible
- Track Materials: Fishing Line, Hand Tools, Eyelets, Roofing Ply, etc.
- Duct Tape
- Incandescent lamps with extra bulbs (if using solar cells for charging)
- 9V batteries and/or DC power supplies for electrolysis.

At the beginning of the competition, a few extra volunteers should remain at Hydrogen Fuel Cell Model Car *Science Bowl Central* to serve as "emergency" officials in the event that one of the scheduled officials does not arrive.

**Hydrogen Fuel Cell Model Car Inspection Checklist**  
For Use By Inspection Official

Car Number \_\_\_\_\_ School \_\_\_\_\_

<p>Inspection Checklist</p> <p><input type="checkbox"/> Car length not greater than 60 cm.</p> <p><input type="checkbox"/> Car width not greater than 30 cm.</p> <p><input type="checkbox"/> Car height not greater than 30 cm.</p> <p><input type="checkbox"/> Original hydrogen fuel cell</p> <p><input type="checkbox"/> Original gas tank (not modified)</p> <p><input type="checkbox"/> Number mounted on each side of car</p> <p><input type="checkbox"/> Sponsor decals mounted on side of car</p> <p><input type="checkbox"/> Eyelet on bottom of car near front end (speed race only)</p> <p><input type="checkbox"/> No components not provided in the original kit.</p> <p><input type="checkbox"/> No batteries or storage device with the exception of the provided hydrogen fuel cell and fuel tank.</p>	<p>Car weight = _____</p> <p style="text-align: center;"><u>Inspection Results</u></p> <p style="text-align: center;"><input type="checkbox"/> Pass</p> <p style="text-align: center;"><input type="checkbox"/> Fail</p> <p>Signature of Inspector</p> <p>_____</p>
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