

# Solar Car Obstacle Course Challenge



Quantum Energy and Sustainable Solar Technologies

# QESST Solar Car Challenge 2016-2017 Hosting Guidelines

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## **Welcome:**

Welcome to the exciting challenge of solar cars. Here you will find the opportunity to design and build a solar car that completes an obstacle course with three challenges to gain the most points and be crowned the best! Or at least have some fun along the way. Many of you are familiar with solar powered cars. These challenges will help you dive deeper into exactly what makes solar cars run and how to optimize them so they can complete the jobs we want them to do.

In this specification packet, you will find:

- Information about the three challenges in the obstacle course (*How do I get points and win?*)
- Requirements for your Engineering Design Notebook.
- Extra information about solar energy and car mechanics to help you get started

## **Day of Competition Expectations:**

1. Regional competitions will be run as workshops. They will have the same rules and guidelines as the state competition. However, the focus is on practicing in an authentic setting. NO awards will be given, but you are encouraged to scrimmage against other teams. QESST scholars will be available to help you with questions and ideas.
2. An engineering design notebook is REQUIRED. You will NOT be allowed to compete if your team checks in at the state competition without a notebook or it appears that you just began a notebook.
3. The events will be run as an open “carnival” competition. All three challenges in the solar car obstacle course will be open to compete for three hours. Your team may complete the challenges in any order you decide. You can complete up to three times in each challenge. Only your highest score will be counted.
4. You can make adjustments to your car in order to meet the specific requirements of each challenge. You do not have to change your car in between challenges, but it is allowed if you want. For instance, you can add attachments (such as a snowplow) that are only part of your car for certain tasks.

## **Vehicle Specifications:**

1. The vehicle must be safe. For instance, there must be no sharp edges, projectiles, etc.
2. The vehicle cannot exceed the following dimensions: Length: 60cm, Width: 30cm
3. The sun's light is the ONLY energy source that may be used to power the vehicle. No rubber bands, etc. allowed. No extra motors or alternative energy storage devices (such as batteries) of any kind are permitted.
4. Solar concentrators, such as mirrors, are permitted, but must be firmly attached to the vehicle.
5. The body of the car must be three-dimensional. The solar cells cannot be used as the body of the car (e.g. teams may not bolt the axles and wheels to the solar cell directly).
6. The vehicle must be clearly labeled with school name.
7. ALL 4 solar panels and motor must be used.

## **Mandatory Materials:**

- You may use all types of materials when designing your car. However, you MUST use the four solar panels and motor provided by QESST (See notes on page 9 for more information).

## **Overview of Obstacle Course Challenges:**

You will be presented with a series of challenges for your car to complete: a sprint challenge, an alignment challenge, and an impact challenge. Each challenge is worth 30 points. Additionally, you will be required to have an engineering design notebook. The notebook will be worth 24 points. At the end of the competition the team with the most points (out of 114) is crowned the "Overall Obstacle Course Champion Car" winner.

**Awards** will be given for the following: (subject to change based on regional competitions)

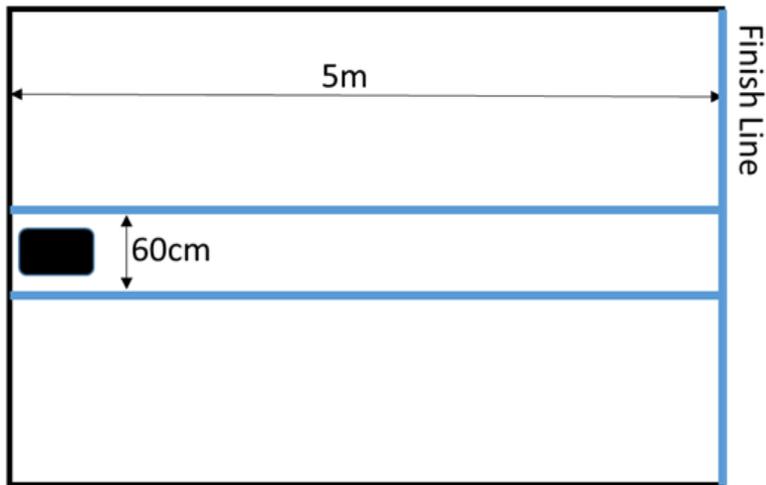
- Best Engineering Design Notebook
- Overall Obstacle Course Champion
- Fastest recorded time
- Best alignment
- Most cans knocked over during impact

## **Challenge # 1 - Sprint Challenge:**

This challenge measures speed. Your car must move 5 meters in the shortest amount of time possible (this is a race against the clock!).

Important design criteria to consider that will help you achieve this goal: **(and added to your notebook)**

- How straight your car goes (e.g. if it goes sideways it will have to travel farther and thus take longer to cross the finish line)
- Good gear ratio (transfer of power, within limitations of starting)
- Solar cell placement and arrangement (more power means a faster car)
- Body and wheel design (needs to be sturdy enough to make it the distance without falling apart, but weight will also affect how fast your car will move)



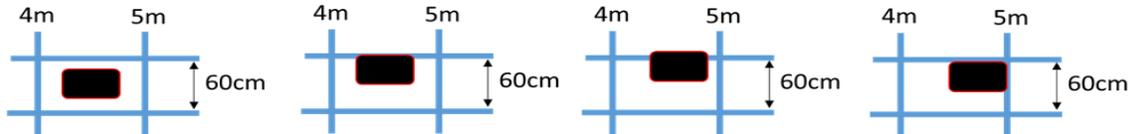
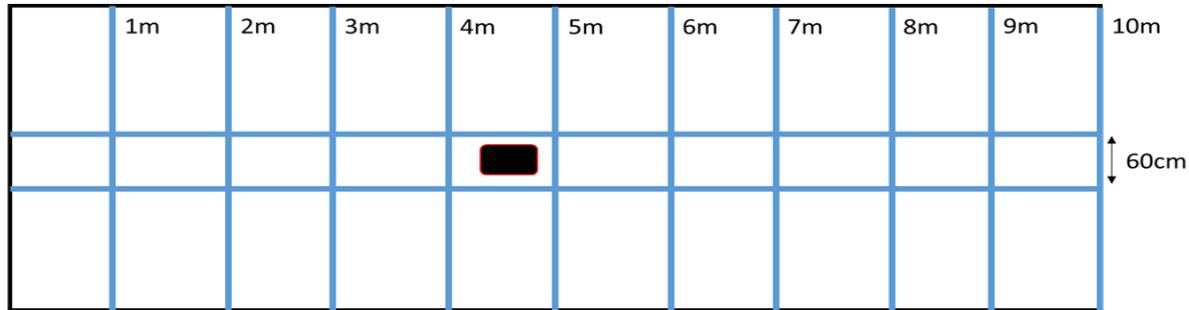
**Sprint Track Specifications (see the figures above)**

1. The length of the race course is 5 meters over flat terrain such as a sidewalk or similar surface.
2. Race lanes are 60 cm wide. It is recommended that your car stay within the lane, but it is not required for this challenge.
3. Lanes are on concrete and designated by blue painters tape.
4. Points are awarded based on the time recorded according to the chart below.
5. Time is measured from the word “go” spoken by the judges to when the first part of the car crosses the finish line.

Time	Points awarded
0-5 seconds	30 points
5-10 seconds	27 points
10-15 seconds	24 points
15-20 seconds	21 points
20-25 seconds	18 points
25-30 seconds	15 points
30-35 seconds	12 points
35-40 seconds	9 points
40-45 seconds	6 points
> 45 seconds	3 point
Does not reach 5 meters	0 points

## **Challenge #2 - Alignment Challenge:**

This challenge measures how well your car can travel in a straight line.



Car is within the lane

Car is outside the lane  
and awarded 4 points

Car is outside the lane  
And awarded 4 points

Car is outside the lane  
And awarded 5 points

## **Track Specifications- see figure above with explanations**

1. The length of the course is 10 meters over flat terrain.
2. Lanes are 60 cm wide.
3. Lanes are on concrete and designated by blue painters tape.
4. Points will be assessed for every meter traveled down the course inside the lane. As soon as any part of the car is over or comes in contact with the blue tape, this portion of the competition will stop and points will be awarded.
5. Tie breaker: If car has reached the maximum 10 meters, it can continue moving down the track. However, the race lane will become narrower until it becomes 30 cm. The same rules apply (e.g. the car must stay within the lines). The car that goes the furthest distance without going outside the lane will be considered the winner.

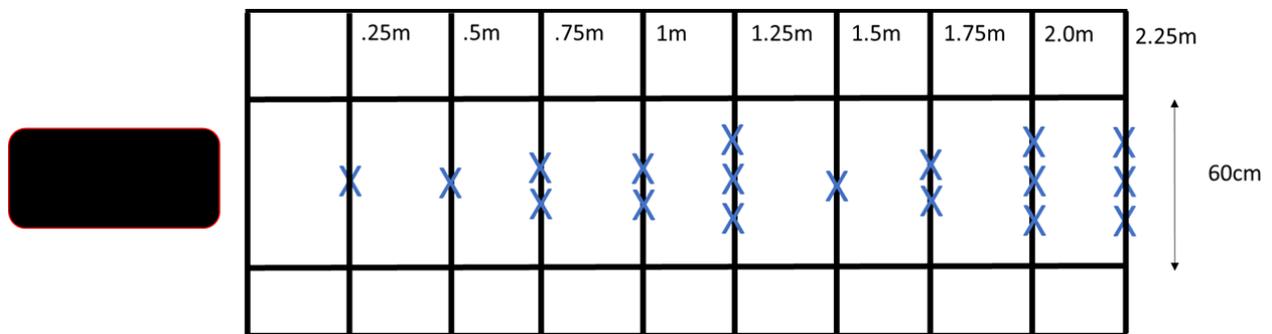
Alignment Challenge	
Distance car travels in a straight line	Points awarded
10 meters	30 points
9 meters	27 points
8 meters	24 points
7 meters	21 points
6 meters	18 points
5 meters	15 points
4 meters	12 points
3 meters	9 points
2 meters	6 points
1 meter	3 point
<1 meter	0 points

### Challenge #3 - Impact Challenge:

This challenge measures your car's ability to remove obstacles from its path, while protecting the car from these obstacles. Specifically, empty soda cans will be placed in the way of the vehicle and the challenge is to remove as many of these cans from the path of travel as possible.

Important design criteria to consider that will help you achieve this goal: **(and added to your Notebook)**

- Torque (turning power) of the wheels (is it sufficient to push the soda cans out of the way?)
- Body and wheel design (needs to push cans out of the path and also keep cans from falling on the solar panels)



## **Track Specifications**

1. Lanes will be 60 cm wide. Soda cans will be located every 0.25m down the lane, as shown in the figure above.
2. X's will be marked on the ground with blue painters tape, and the judges will place the cans there as shown.
3. Cans will be stacked as follows:
  - a. Cans will be stacked one-high for lines 1-5.
  - b. Cans will be stacked two-high for lines 6-8.
  - c. Cans will be stacked three-high for the final line.
    - i. For example, there are three cans located at 1.25m. There are six cans (three cans on top of three cans) at 2 m, and nine cans located at 2.25 m (three cans on top of three cans)
4. The front of the car will start at 0 m. The car will move forward and knock over as many cans as it can without help from team members. For example, team members cannot remove a soda can if it falls on the solar panels. The competition will continue until the car comes to a complete stop, passes 2.25m, or goes far enough off course that it will not come back. All cans knocked over will count towards points: i.e. if your car passes one set of cans without knocking them over, you can still gain points for cans knocked over further down the track. Each can that falls over or moves away from the X will count as 1 point. (Total possible points for this competition are 30)
5. Tie Breaker 1: The car that knocked down the most cans, traveled the furthest and knocked over the furthest can from the start line. (If you have knocked over all 30 cans and have a remaining ticket, additional cans will be set up. These cans will not count towards more points in the overall competition, but will help determine the individual winner of this challenge.)

## **Engineering Design Notebook:**

Engineers document their project work in an engineering design notebook. The purpose is to record written ideas, sketches, work session summaries, research findings, testing results and interview information in chronological order.

1. Why are notebooks important?
  - a. An engineering notebook is a legal document used to prove ownership of ideas
  - b. Using a notebook will improve documentation, sketching, research, and communication skills
  - c. A notebook protects the groups' ideas if a member leaves the project
2. Your notebook should document at least 3 completed design cycles.
3. Grading of notebooks will be based on the MESA rubric.
4. The design notebook is worth 24 points. (See **APPENDIX C** for a student example)

## **Notes to MESA Coaches:**

1. Teams will receive 3 different colored tickets to each challenge. There is no particular order that must compete. The teams will first check in with the lead judge to check vehicle specs (to ensure that no alternative energy sources have been added). They will then present their ticket to the event judge to compete.
2. As the competition comes to a close, teams will be given a 5 minute warning. If they are not in line during that time to compete, their ticket(s) will be forfeited. Students should be told that time is a constraint. QESST will be running several challenges at a time, so this should not be an issue.
3. QESST will provide 1 motor and 4 solar panels to 1 team at each school. If more than one team wishes to compete per school, schools may purchase the items below:
  - [http://www.pitsco.com/Motor\\_280](http://www.pitsco.com/Motor_280)
  - [http://www.pitsco.com/Solar\\_Mini\\_Panels](http://www.pitsco.com/Solar_Mini_Panels) (1.0V, 400 mA)

## **Judging and Evaluation:**

### DISPUTES:

- Teams can only dispute their own results and not dispute or complain about other team's designs/results.
- Should there be a dispute, the Lead Judge should briefly address the dispute with parties making the protest and the other judges at the time of the dispute.

### JUDGES:

- Judges will be fair.
- Judges will discourage any interruptions to their duties, because distractions can cause a delay in the event.
- Judges will refer people to the committee chairmen, registration or other volunteers for questions and help.

**Rubric for Engineering Design Notebooks (EDN).**

EDN Goals	3	2	1	0
<b>1. Explore</b>				
<b>1.1 Problem Statement.</b> Accurately describes, in your words, the design objective (includes success criteria, constraints constants and variables)	<b>Specific</b> description of problem, success criteria, constraints, variables and constants	Basic...	Weak...	No...
<b>1.2 Depth of Free exploration.</b> Prior knowledge, brainstorming & hands-on exploration documented.	<b>Numerous</b> examples of brainstorming and hands-on exploration observations.	Regular...	Few...	No...
<b>1.3 Research in Design:</b> Research ideas about your design that might be useful. Record information using different sources (e.g. books, websites, interviews from experts).	<b>Clear</b> analysis of other design pros/cons.	Basic...	Scant...	No...
<b>2. Design</b>				
<b>2.1 Design Plan.</b> Includes reasoning on your design choices (materials used, modifications, etc.). Use data from past trials, research and design considerations.	<b>Clear</b> reasons given (based on data or research) for each design choice.	Basic...	Scant...	No...
<b>2.3 Design sketching and/or photos.</b> Prior & during build, team sketches, 2-D or 3-D perspective drawings.	<b>Numerous</b> representations of each design iteration.	Regular...	Scant...	No...
<b>3. Test</b>				
<b>3.1 Observation.</b> Data & written observations (tables, graphs, labeled drawings, etc.).	<b>Numerous</b> presentation of quantitative & qualitative data, graphs & charts follow design progression.	Regular...	Scant...	No...
<b>3.2 Reflection/Analysis.</b> Assesses pros and cons of design/materials, testing procedure, etc. Apply test results and analysis to pose a theory, recommend and argue for a next step, or draw an insightful conclusion. Restate the purpose in your conclusion.	<b>Detailed</b> reflection shows how design considerations and logic flowing from research, test analysis, etc.	Basic...	Scant...	No...
<b>4. EDN Organization</b>				
<b>4.1 Structured.</b> Includes Table of Contents with key elements. Elements of EDN can be used to answer judges questions easily	<b>Clear</b> organization utilizes defined sections.	Basic...	Minimal..	No...
<b>4.2 Labeled.</b> Clearly labeled with School and Team Members names.			Yes	No
<b>Column Totals (for selected categories)</b>				
<b>Final Score (out of 25)</b>				

Comments/Suggestions:

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