Clark Public Utilities

Solar Car Challenge

Judging Guide

Clark Public Utilities POWER ZONE™

green lights Clark Public Utilities

Clark Public Utilities

TABLE OF CONTENTS

JUDGING GUIDE

Challenge Details and Rules

WHO CAN PARTICIPATE?

This challenge is designed for elementary and middle high school students. Criteria for success are scaled to match the grade level (see rubrics beginning on page 10).

Students (with guidance from teachers/coaches) will design, build, and race hybrid solar battery-powered electric powered cars that include both a solar module and a battery pack. Teams will be judged on their vehicle's performance in a race (45%) and performance in a team interview with supporting engineering process documentation (55%). We recommend team sizes of 2 – 4 students per team for the most meaningful experience.

2019 Clark Public Utilities Solar Car Challenge Winners

TRACK SPECIFICATIONS

- Track Length: ~20'.
- Lane Width: ~12".
- Number of lanes: 6 lanes.
- Starting Gate: about 16 inches from the beginning of the track.
- Track Surface: Track sides/lanes are comprised of 1/2" PVC pipe, the surface of the track is the gym floor.
- Lighting: (22) 68 watt LED lights 32" above track (center, left, and right).
- LED lights producing 330,000 lumens, 1428 watts, set at 45-degree angle

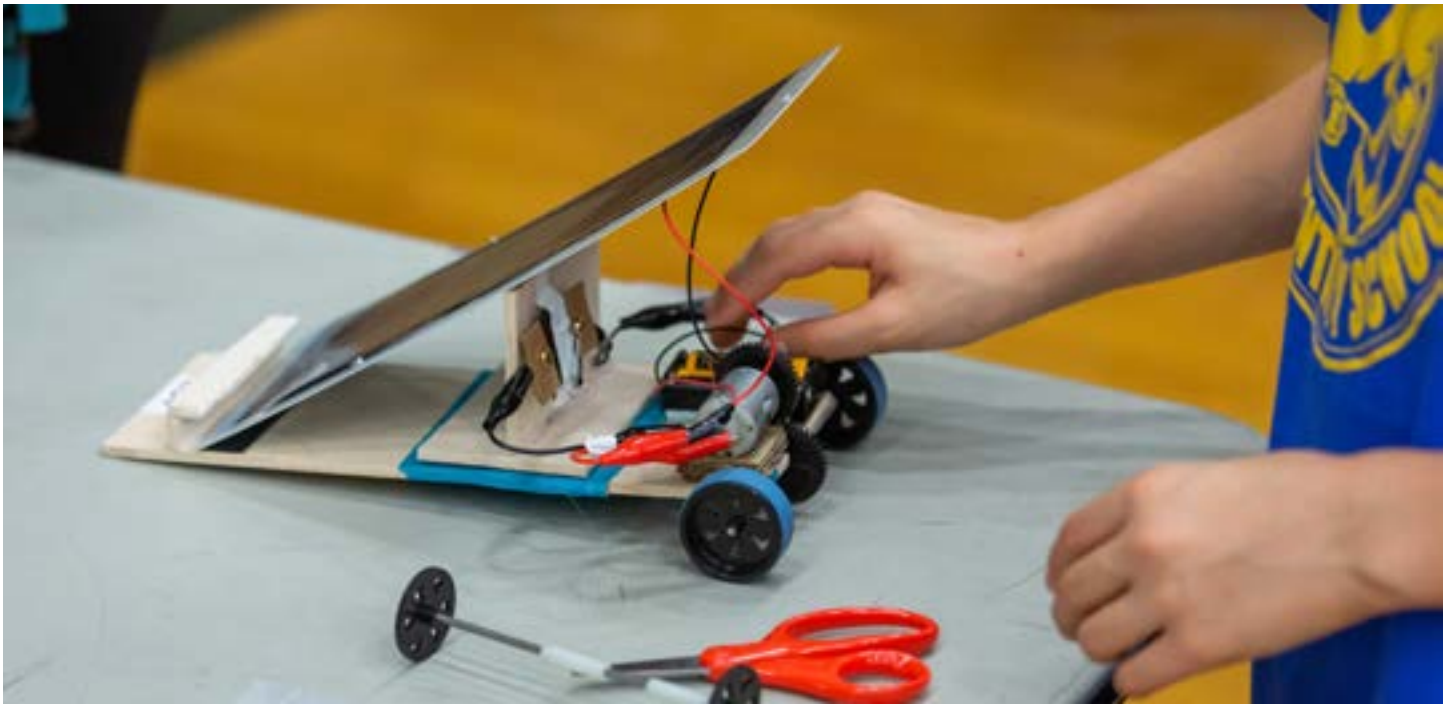
2024 Clark Public Utilities Solar Car Challenge Track (Track Subject to Change)

PERFORMANCE DETAILS

The 2020 Clark Public Utilities Solar Car Challenge is a holistic engineering competition. This means that teams will be judged on a number of factors:

a. Speed (45%).
b. Documentation of engineering design process AND team interview (55%).

The format of the solar car races will be double elimination, meaning that each vehicle will race at least two times.



Speed: Students' Innovative Designs Raced During the 2019 Solar Car Challenge

Overview

QUALIFYING CHECKLIST

Each car will be examined on the day of the challenge to ensure the car meets the vehicle specifications outlined for the challenge.

RACE (45% WEIGHTED SCORE)

The format of the speed trial will be double elimination meaning that each vehicle will race at least two times. There will be a bracket system developed and bracket movement will be tracked through the Solar Car Challenge app. This app will be available to download and track your team's progress through the race brackets.

DOCUMENTATION OF ENGINEERING DESIGN PROCESS AND TEAM INTERVIEW (55% WEIGHTED SCORE)

TEAM POSTER

Each team must provide comprehensive documentation that reflects the engineering and design process. Knowledge should be demonstrated through a culminating team poster with supporting evidence from individual engineering notebooks. **A rubric will be used to assign points for the following steps in the engineer and design process:**

Ask, Research, Imagine/Plan, Create, Test and Evaluate, and Improve.

The purpose of the engineering notebook is to document each individual team member's process and notes. The team poster is the summation of the group's collaborative effort and should be a comprehensive snapshot.

TEAM INTERVIEW

Each team will be interviewed by a volunteer and may be asked questions related to the engineering design process or renewable energy. Sample questions are on page 15.

A rubric will be used to assign points for the following categories:

- Content
- Clarity
- Teamwork
- Preparedness/Research

The judges will require more detailed documentation from the high school level, and less formal from the elementary school level students.

Materials List and Specs

REQUIRED MATERIALS	PROHIBITED MATERIALS/PRACTICES
• Provided Motor (see appropriate motor for ES/MS or HS) • Provided PV Module – Pitsco Ray Catcher 2.76V module • Switch (any that is safe – not provided) • Battery holder • 2 AA Batteries • Provided resistor – 6.2 Ω (*HS only) • 1 red LED (*MS and HS only)	• Any vehicle deemed unsafe by any judge (Note: utilities are experts in electrical safety!) • Additional power sources beyond what's included (required) • Modifying power sources (solar panel and batteries) • Tampering with motor (re-wound or disassembled) • Additional purchased materials beyond $10 in cost (receipts for purchased materials must be included in documentation of design in notebooks)

IN THE KIT – ES	IN THE KIT – MS
• 1 PV Module (Pitsco Ray Catcher Solar Module, 2.76V, 1A) • 1 small DC motor (Pitsco Motor 280) • 1 2-AA battery holder • 2 rechargeable AA batteries • 2 metal axles • 4 rubber bands (2 thick, 2 thin) • 8 gears (2 mm hole) • 8 gears (1/8" hole) • 4 nylon spacers • 4 wheels (2 large, 2 small) • 2 balsa wood sheets • 1 solar panel blank (cardstock) • 12 pack mini alligator clip leads • 2 small metal alligator clips • 2 screw eyes	• 1 PV Module (Pitsco Ray Catcher Solar Module, 2.76V, 1A) • 1 small DC motor (Pitsco Motor 280) • 1 2-AA battery holder • 2 rechargeable AA batteries • 2 metal axles • 4 rubber bands (2 thick, 2 thin) • 8 gears (2 mm hole) • 8 gears (1/8" hole) • 4 nylon spacers • 4 wheels (2 large, 2 small) • 2 balsa wood sheets • 1 solar panel blank (cardstock) • 12 pack mini alligator clip leads • 2 small metal alligator clips • 2 screw eyes • **3 red LEDs**

VEHICLE SPECIFICATIONS FOR QUALIFICATION

- Vehicle size: maximum length of 38 cm, width of 30 cm, and height of 30 cm.
- The solar panel cannot be used as the body of the vehicle.
- The solar panel cannot be altered (e.g. drilled, sanded, or cut).
- Vehicles must be powered by 2 AA batteries provided during the day of the challenge. The batteries must be connected to a working switch that can be turned off.
- The solar panel is not required to be connected to the on/off switch.
- There must be an available 5 cm square of free space for team number sticker.
- Middle school and high school teams must include a minimum of one red LED in their design that lights up when vehicle is running.

Score Breakdown

TOTAL CHALLENGE POINTS	% SCORE	POINT STRUCTURE
Race Trials (Team Heat Races, modified double elimination)	**45%**	1st place: **5 points** 2nd place: **3 points** 3rd place: **1 point** DQ* or DNC**: **0 points**
Documentation of Engineering Design Process	**30%**	Poster and engineering notebook **500 maximum points**
Team Interview	**25%**	Content, clarity, teamwork, preparedness/research, final product **400 maximum points**

* DQ – Disqualified
** DNC – Did Not Complete race/length of the track

You may want to create a spreadsheet to compile all results by team for races and the interview, and design/documentation challenges to determine the winner of the intramural challenges. For instance, columns could include the following:

- Team Number/Name
- Race points earned for each heat
- Total Race Raw Points
- Design/Documentation Raw Points
- Interview Raw Points
- Total Raw Score
- Final weight adjusted Total Score

Ways to Win

The scores will be weighted by each team's race performance, design, and interview. The following tables indicate the categories in which teams can win an award.

RACING COMPETITION

Division	Awards
Elementary School	1st, 2nd, 3rd
Middle School	1st, 2nd, 3rd

JUDGES CHOICE

Division	Awards
Elementary School	1st
Middle School	1st

INTERVIEW AND ENGINEERING DESIGN DOCUMENTATION

Division	Awards
Elementary School	1st, 2nd, 3rd
Middle School	1st, 2nd, 3rd

TRACK OFFICIALS CHOICE

Division	Awards
Elementary School	1st, 2nd, 3rd
Middle School	1st, 2nd, 3rd

JUDGING GUIDE: QUALIFICATIONS

Qualification Checklist: Elementary School

Before racing in intramurals and at the main event, cars must pass inspection.

SIZING

- ❑ 38 cm or less in length.
- ❑ 30 cm or less in width.
- ❑ 30 cm or less in height.

CIRCUITRY

- ❑ Circuits have solar panel and battery packs wired on separate parallel branches (see spec sheet).
- ❑ No additional power sources aside from 2 x AA battery pack and 2.76V Pitsco Ray Catcher solar module.
- ❑ Switch integrated into circuit (see spec sheet) either in series with batteries or in series with motor. **Not in series with panel**.

MATERIALS

- ❑ Motors from original team kit used (Pitsco Motor 280).
- ❑ Solar panel is not used as chassis.
- ❑ Outside (found or created) materials are less than $10 in value. This will need to be determined through questioning and volunteer discretion.

ADDITIONAL

- ❑ No damage done to solar panel rendering it unable to be reused.
- ❑ Visible 5 cm square for registration sticker.

Qualification Checklist: Middle School

Before racing in intramurals and at the main event, cars must pass inspection.

SIZING

- ❑ 38 cm or less in length.
- ❑ 30 cm or less in width.
- ❑ 30 cm or less in height.

CIRCUITRY

- ❑ Circuits have solar panel and battery packs wired on separate parallel branches (see spec sheet).
- ❑ No additional power sources aside from 2 x AA battery pack and 2.76V Pitsco Ray Catcher solar module.
- ❑ Switch integrated into circuit (see spec sheet) either in series with batteries or in series with motor. **Not in series with panel**.

MATERIALS

- ❑ Motors from original team kit used (Pitsco Motor 280).
- ❑ Solar panel is not used as chassis.
- ❑ Outside (found or created) materials are less than $10 in value. This will need to be determined through questioning and volunteer discretion.

ADDITIONAL

- ❑ No damage done to solar panel rendering it unable to be reused.
- ❑ Visible 5 cm square for registration sticker.

JUDGING GUIDE: RUBRICS/SCORING

Rubric Example: Elementary

ELEMENTARY SCORING SHEET: POSTER & NOTEBOOK		
School:	Team Name:	Team Number:

Please assign teams a score between 1 and 100 for each of the following five criteria:

Ask: Research the Problem			Score:
1 Students did not conduct research.	**50** Students conducted research about car materials.	**100** Students conducted research about car materials and content. Students used research to address questions.	

Imagine/Plan: Develop Possible Solutions			Score:
1 Students selected plan for prototype design at the outset of their design process.	**50** Students selected design and listed components.	**100** Students selected design and listed components. Students explored wheel size, gear ratio, friction, etc.	

Create: Build a Prototype			Score:
1 Students built a prototype.	**50** Students built a prototype with pictures included.	**100** Students built a prototype, with detailed notes about adjustments made.	

Test, Evaluate, and Improve			Score:
1 Students tested prototype, but did not redesign.	**50** Students tested prototype, listed results and developed a second design.	**100** Students tested prototype, listed results, made a second design, and retested, taking careful notes.	

Final Design: Innovation			Score:
1 Vehicle is not decorated and students did not document its usefulness.	**50** Vehicle is somewhat innovative in nature, but team did not document ways in which their car is innovative.	**100** Student creativity and innovation is clearly present in vehicle material testing or selection. Vehicle uses recycled materials or team creativity is documented.	

Judges Choice Nominee?	❑ **Yes**	❑ **No**
Notes:		
Judge Name:		

Rubric Example: Elementary

ELEMENTARY SCORING SHEET: INTERVIEW		
School:	Team Name:	Team Number:

Please assign teams a score between 1 and 100 for each of the following five criteria:

Content			Score:
1 Students demonstrated little knowledge of science and engineering content.	**50** Students demonstrated knowledge of science and engineering content.	**100** Students mastered science and engineering content as they relate to renewable energy.	

Clarity			Score:
1 Students selected plan for prototype design at the outset of their design process.	**50** Students answered questions and supported their claims with evidence and reasoning.	**100** Students answered questions with comprehensive support and communicated ideas with real world application.	

Teamwork			Score:
1 1 student answered all questions.	**50** More than 1 student answered questions.	**100** Many members of the team answered questions and worked collaboratively.	

Research/Preparedness			Score:
1 Students shared their approach to the challenge, but with little detail.	**50** Students demonstrated familiarity with components and asked initial questions before they began the design process.	**100** Students demonstrated familiarity with components, asked questions, and mentioned multiple sources to support their decisions throughout the process.	

Judges Choice Nominee? ❑ Yes ❑ No
Notes:
Judge Name:

Rubric Example: Middle School

MIDDLE SCHOOL SCORING SHEET: POSTER & NOTEBOOK		
School:	Team Name:	Team Number:

Please assign teams a score between 1 and 100 for each of the following five criteria:

Ask: Research the Problem			Score:
1 Students did not conduct research.	**50** Students conducted research about car materials.	**100** Students conducted research about car materials and content. Students used research to address questions.	

Imagine/Plan: Develop Possible Solutions			Score:
1 Students selected plan for prototype design at the outset of their design process.	**50** Students selected design and listed components.	**100** Students selected design and listed components. Students explored wheel size, gear ratio, friction, etc.	

Create: Build a Prototype			Score:
1 Students built a prototype.	**50** Students built a prototype with pictures included.	**100** Students built a prototype, with detailed notes about adjustments made.	

Test, Evaluate, and Improve			Score:
1 Students tested prototype, but did not redesign.	**50** Students tested prototype, listed results and developed a second design.	**100** Students tested prototype, listed results, made a second design, and retested, taking careful notes.	

Final Design: Innovation			Score:
1 Vehicle is not decorated and students did not document its usefulness.	**50** Vehicle is somewhat innovative in nature, but team did not document ways in which their car is innovative.	**100** Student creativity and innovation is clearly present in vehicle material testing or selection. Vehicle uses recycled materials or team creativity is documented.	

Judges Choice Nominee? ❑ Yes ❑ No
Notes:
Judge Name:

Rubric Example: Middle School

MIDDLE SCHOOL SCORING SHEET: INTERVIEW		
School:	Team Name:	Team Number:

Please assign teams a score between 1 and 100 for each of the following five criteria:

Content			Score:
1 Students demonstrated little knowledge of science and engineering content.	**50** Students demonstrated knowledge of science and engineering content.	**100** Students mastered science and engineering content as they relate to renewable energy.	

Clarity			Score:
1 Students answered all questions.	**50** Students answered questions and supported their claims with evidence and reasoning.	**100** Students answered questions with comprehensive support and communicated ideas with real world application.	

Teamwork			Score:
1 1 student answered all questions.	**50** More than 1 student answered questions.	**100** Many members of the team answered questions and worked collaboratively.	

Research/Preparedness			Score:
1 Students shared their approach to the challenge, but with little detail.	**50** Students demonstrated familiarity with components and asked initial questions before they began the design process.	**100** Students demonstrated familiarity with components, asked questions, and mentioned multiple sources to support their decisions throughout the process.	

Judges Choice Nominee? ❑ Yes ❑ No
Notes:
Judge Name:

JUDGING GUIDE: INTERVIEW QUESTIONS

Interview Example: Elementary

Team Name:	Team ID:

1.	(Briefly Introduce Yourself) Icebreaker: Why is renewable energy important to you? What are you most excited about at the competition today?
2.	What kind of research did you your team do to prepare for the challenge?
3.	How did you choose the components for your solar car vehicle?
4.	What additional materials did you use to make your car? Why?
5.	Did you have any issues with friction? How did you reduce friction?
6.	When building your car, what kind of obstacles or challenges did you face?
7.	What trade-offs did you make when designing your car and selecting components?
8.	What changes did you make to your car that led to the most performance gains?
9.	Describe any redesign processes your team went through before deciding on the final model.
10.	How did the team divide up the tasks needed to make the car run smoothly?

Interview Example: Middle School

Team Name:	Team ID:

1.	(Briefly Introduce Yourself) Icebreaker: Why is renewable energy important to you? What are you most excited about at the competition today?
2.	What kind of research did you your team do to prepare for the challenge?
3.	How did you choose the components for your solar car vehicle?
4.	What additional materials did you use to make your car? Why?
5.	Did you have any issues with friction? How did you reduce friction?
6.	When building your car, what kind of obstacles or challenges did you face?
7.	What trade-offs did you make when designing your car and selecting components?
8.	What changes did you make to your car that led to the most performance gains?
9.	Describe any redesign processes your team went through before deciding on the final model.
10.	How did the team divide up the tasks needed to make the car run smoothly?