HYBRID RACER XL

OVERVIEW

Hybrid Racer XL provides a hands-on opportunity for students to apply science, technology, engineering, and mathematics (STEM) concepts, along with leadership and 21st century skills such as creativity, teamwork, and problem-solving skills, as they design, construct, and race a dual-powered (solar and battery) car. Special annual design requirements (if any) will be posted on the TSA website under *Themes & Problems*.

ELIGIBILITY

One (1) team of two to four (2-4) individuals per chapter may participate; one (1) entry per team.

TIME LIMITS

PRELIMINARY ROUND

A. All components of the chapter's entry turned in at the place and time stated in the conference program.

B. All models meeting safety and performance criteria are given up to two (2) time trials.

SEMIFINAL ROUND

A. Five (5) minutes are allowed for the semifinal interview.

ATTIRE

TSA competition attire is required for this event.

PROCEDURE

PRE-CONFERENCE

A. Participants review the TSA Honor Statement for Competitive Events found in the General Rules.

B. Participants review the Use of Generative Artificial Intelligence (GenAI) found in the General Rules.

C. Participants access the annual design requirements (if any) posted on the TSA website under *Themes & Problems*.

D. Participants design and create their dual-powered car while working within the required specifications.

E. Participants develop a documentation portfolio.

F. Participants prepare and record their design processes on a showcase display that includes their dual-powered model.

G. The chapter will create a car name (the name cannot identify the school or chapter). The car name will be incorporated into the theme of the showcase display.

H. The team will create video evidence of the solution using solar power, but the preliminary round will take place indoors during the conference.

PRELIMINARY ROUND

A. Participants report to the time and place stated in the conference program and check in:

1. A dual-powered model car
2. Showcase display
3. Documentation portfolio

B. Entries are reviewed by judges to determine specification adherence and safety on the track.

C. Solutions that are disqualified for any reason will not be permitted to participate in time trials or the preliminary round head-to-head races.

D. All models meeting safety and performance criteria will be given up to two (2) time trials.

E. During the preliminary round, the following procedures apply.

1. Fastest times from the time trials will determine the top twenty-four (24) teams. A list of the twenty-four (24) teams is posted on-site.
2. Judges score the top twenty-four (24) showcase displays, models, and documentation portfolios. The top twenty-four (24) teams will complete a single elimination head-to-head race bracket to score points.

F. Results of the showcase display and model are combined with scores from the single elimination head-to-head race to determine the semifinalists.

G. A list of twelve (12) semifinalists will be posted.

SEMIFINAL ROUND

A. Semifinalist interview must include a minimum of two (2) team members.

B. Five (5) minutes are allowed for the semifinal interview.

C. Combined score of the showcase display, model, head-to-head bracket, and the interview will determine the top ten (10) finalists.

D. The top ten (10) finalists will be announced during the conference award ceremony.

REGULATIONS AND REQUIREMENTS

Students will work to develop their leadership and 21st century skills in the process of preparing for and participating in this TSA competitive event. The development and application of those skills must be evident in their submission, demonstration, and/or communication pertaining to the entry.

PRE-CONFERENCE

A. Team must create a showcase display.

B. Size of the showcase display (including the solar car model) may not exceed 15" deep x 30" wide x 48" high.

C. Showcase display must include the following components:

1. Car name (the name cannot identify the school or chapter).
2. Engineering Design Process. Each step clearly identified. Design process description, including pre-testing notes of various configurations of the model and revision notes about the model design throughout the process.
3. Design drawings:
   a. Drawings must show the model with a minimum of two (2) views.
   b. Drawings must be developed using standard engineering practices and procedures (including measurements/dimensions).
   c. Drawings may be produced using traditional drafting methods or CAD.
4. QR code with a link to three (3) videos of your car using solely solar power to travel 20 meters. Must show that batteries are not in place for the three (3) runs. The maximum length of each video is ninety (90) seconds. The judges should be able to scan the QR code with a smartphone. Viewing cannot require any downloads or require any permissions.

D. Documentation Portfolio: (to be placed within the showcase display)

1. Documentation materials (comprising "a portfolio") are required and must be secured in a clear front report cover with the following single-sided, 8½" x 11" pages, in this order:
   a. Title page with the event title, the team identification number, the conference city and state, and the year; one (1) page
   b. Table of contents; pages as needed
   c. Components list (see Supplied Components List worksheet); pages as needed
   d. Run Log (see Run Log form) with times using solar power or battery power on a 20-meter track. The minimum number of runs is five (5); one (1) page
   e. Resources and AI Reflection (see 2027 & 2028 Forms Appendix); maximum of four (4) pages

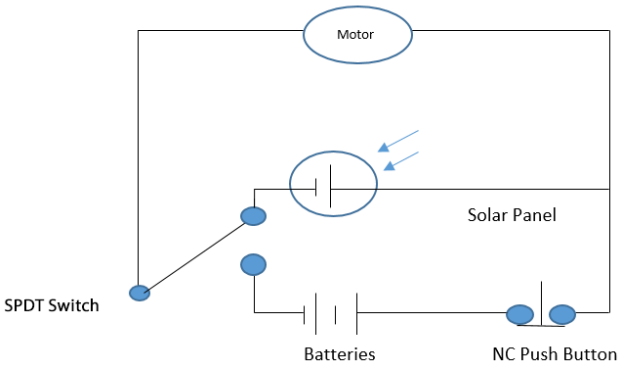
E. Dual-Powered Model Car:

1. Materials used to construct the model car must cost less than $50. The $50 does not include the cost of the solar panel.
2. Original receipts for all materials purchased must be recorded in the Supplied Components List.
3. If using recycled materials, documentation must show how these items were obtained.
4. Recycled materials are not included in the $50 maximum.
5. Model cars that exceed the $50 construction cost limit will be disqualified from the competition.
6. Vehicle must be structurally sound without the solar panel attached.

F. Solar Paneling:

1. One (1) solar panel (limited to a maximum output of 3.2 W), and one (1) motor (limited to a maximum 3.0 VDC) are allowed per car
2. Solar panels cannot be shaved, drilled, or delaminated.
3. Motors cannot be re-wound or disassembled.
4. If an evaluation group convened by the event coordinator determines that the solar panel and/or motor have been modified, the car and team will be disqualified from the competition.
5. Solar panel cannot be used as the chassis, or body, of the car.
6. Axles and wheels cannot be directly attached to the solar panel.
7. Reflectors, supports, and power leads can be added to these components as needed, but they must fit within the required dimensions.
8. Model car must, with the solar panel attached, not exceed the following dimensions:
   a. 60 cm (23 5/8 inches) length
   b. 30 cm (11 13/16 inches) width
   c. 30 cm (11 3/4 inches) height (as measured from the surface the car is resting upon to the highest point of the car, with all its components attached)

Wiring Diagram



9. Each vehicle must include a mounted battery holder that is capable of holding two AA batteries. This system needs a switch and button as illustrated. This is to be used at the starting line as follows:
   a. on the "READY" command the button is depressed and held, this opens the circuit.
   b. on the "SET" command the switch is flipped, to connect the batteries to the motor.
   c. on the "GO" command the button is released, thereby closing the circuit, sending power to the motor, causing the vehicle to move.
10. The team is encouraged to decorate the body of the car, but a clearly visible 3cm square space must be available on the car to display the team ID#.
    a. All onsite racing will be completed indoors using two (2) provided AA batteries

G. A student-designed attachment device must be part of the car to accommodate the easy attachment and removal from a guide wire for steering. A purchased screw eye or eye bolt is not considered a student designed attachment device.

1. A guide wire, such as fishing line, will be no more than 1.5 cm (⅝") from the surface of the track.
2. Wire will go through the attachment device on the car and serve as a steering mechanism to keep the car in its lane. **This must be done without disconnecting the guide wire.**
3. Both ends of the guide wire will be fixed to the track. This is the only allowable method of steering the car.
4. No radio control is permitted in the car.
5. Lane changing or lane crossing will result in a Did Not Finish (DNF) standing.
6. A car's race that is impacted by an out-of-control vehicle will be allowed an opportunity to run the race again.
7. A car that lacks steering control and interferes with other cars in other lanes will not be allowed to race again.

H. If a car is deemed unsafe, it will not be allowed to run in the time trials or the semifinalist races.

I. If the model is safe, but does not meet the required specifications, it will be allowed to run in the time trials but not the semifinalist races.

J. Remainder of the vehicle can be innovative in design and materials.

PRELIMINARY ROUND

Time Trials

A. Race lane must be 60cm wide and 20m long.

B. Track will be a hard flat surface indoors such as convention center concrete. The floor surface for the national TSA conference will be posted on the TSA website under *Themes & Problems*.

C. All on-site racing will be conducted using provided batteries however your solar panel must still be in place.

   1. Prior to receiving provided batteries, teams will conduct an on-site solar test with a solar lamp to power the vehicle showing its solar power function prior to the time trail.
   2. Failure of the solution to display operational capability of solar power will result in the team not receiving batteries or being allowed to participate in the time trails.

D. Time trial/race specifications are as follows:

   1. Tables will be set up for teams to make adjustments and minor repairs to cars prior to each time trial and the semifinalist heats.
      a. Teams that are "next up" to be timed or raced are given priority to use the tables.
      b. Teams must supply their own tools.
   2. Time trials and semifinalist races should not be delayed. If a repair is needed during time trials or head-to-head races, a team will get one three (3)-minute time limit for repairs to be made. If a repair is required during the time trials, the team will not receive a repair time during the head-to-head races. Soldering irons or hot melt glue are not permitted for repairs.
   3. Prior to semifinals, teams will have an opportunity to perform up to two (2) trial races during a practice run session.
   4. At race time, each car will be placed with the most forward part of the vehicle set even with the starting line and all of its wheels in contact with the ground.
   5. No more than two (2) team representatives will be allowed in the race area; one at the starting line, one to catch.
   6. All cars will be started when the official signal is given.
      a. Each car will have up to two (2) time trials, unless otherwise determined by the event coordinator.
      b. Fastest time recorded will determine the twenty four (24) cars to race in the head-to-head single elimination tournament and display judging portion.
      c. If, for any reason, a car is not able to participate in the time trials, or race at its scheduled time, it may be disqualified.
   7. Judges will note the official time for each time trial.
      a. At the time designated, if a car does not start the time trial, OR if during the time trial it does not finish, it will be noted as a Did Not Finish (DNF).
      b. If a car has a false start, the entry will be given one (1) more opportunity to race.
   8. One (1) team member must wait at the finish line to catch the vehicle for each timed trial. Team members are responsible for finding someone to catch their vehicle if another team member is unavailable.
   9. After each timed trial or race, the vehicle and team member must remain at the finish line until the time is recorded for the vehicle.
   10. No one, including team members and spectators, may accompany or touch the vehicle on the track during a timed trial or semifinalist race.
      a. Vehicles stalled on the track can be retrieved after the end of the trial or the race has been declared by the lead judge.
      b. A violation of this rule will result in disqualification of the offending team.

11. Challenges must be made before the next timed trial or race begins.
    a. Any challenges must come from team members who are actively competing, not the coach/advisor, parent, or coordinator.
    b. Any challenges need to be directed to the lead judge.
    c. Decisions of the judges regarding challenges are final.
12. Only competing students and race officials may be in the race area.
    a. Spectators, including coaches/advisors, parents, coordinators, and non-competing students, must remain in the designated spectator area throughout the duration of races.
    b. Teams will be disqualified if a spectator, including a coach/advisor or parent, interferes with a race. This includes a coach/advisor or parent helping team members get their car on/off the guide wire.
13. Judges may inspect cars at any time before, during, and after timed trials or semifinalist races.
14. Any additional rules, regulations, or guidelines established by the event coordinator must be followed.

SEMIFINAL ROUND

A. A team representative will report at the time and location printed in the conference program for an interview time.
B. A minimum of two (2) team members must be present for the interview.
C. Participants will participate in a five (5) minute interview to answer questions related to solar power and the manufacturing process of the solar car model.
D. All teams will report at the time and location printed in the conference program to pick up the entries.

EVALUATION

PRELIMINARY ROUND

Tier 1

A. Time trial results

Tier 2

B. Showcase display and model
C. Documentation portfolio
D. Head-to-head race results

SEMIFINAL ROUND

A. Semifinalist interview

Refer to the official rating form for more information.

GENERATIVE ARTIFICIAL INTELLIGENCE

Generative Artificial Intelligence (GenAI) is permitted for this event. Refer to the Use of Generative Artificial Intelligence (GenAI) for Competitive Events found in the General Rules and Regulations.

STEM INTEGRATION

This event has connections to the STEM areas of Science, Technology, Engineering, and Mathematics.

LEADERSHIP AND 21ST CENTURY SKILLS

This event provides opportunity for students to build and develop leadership and 21st century skills including but not limited to – Communication, Collaboration/Social Skills, Initiative, Problem Solving/Risk Taking, Critical Thinking, Perseverance/Grit, Creativity, Relationship Building/Teamwork, Dependability/Integrity, and Flexibility/Adaptability.

CAREERS RELATED TO THIS EVENT

This competition has connections to one (1) or more of the careers below:

- Energy efficiency technician
- Mechanical engineer
- Solar engineer
- Solar panel installer
- Solar sales consultant

SUPPLIED COMPONENTS LIST

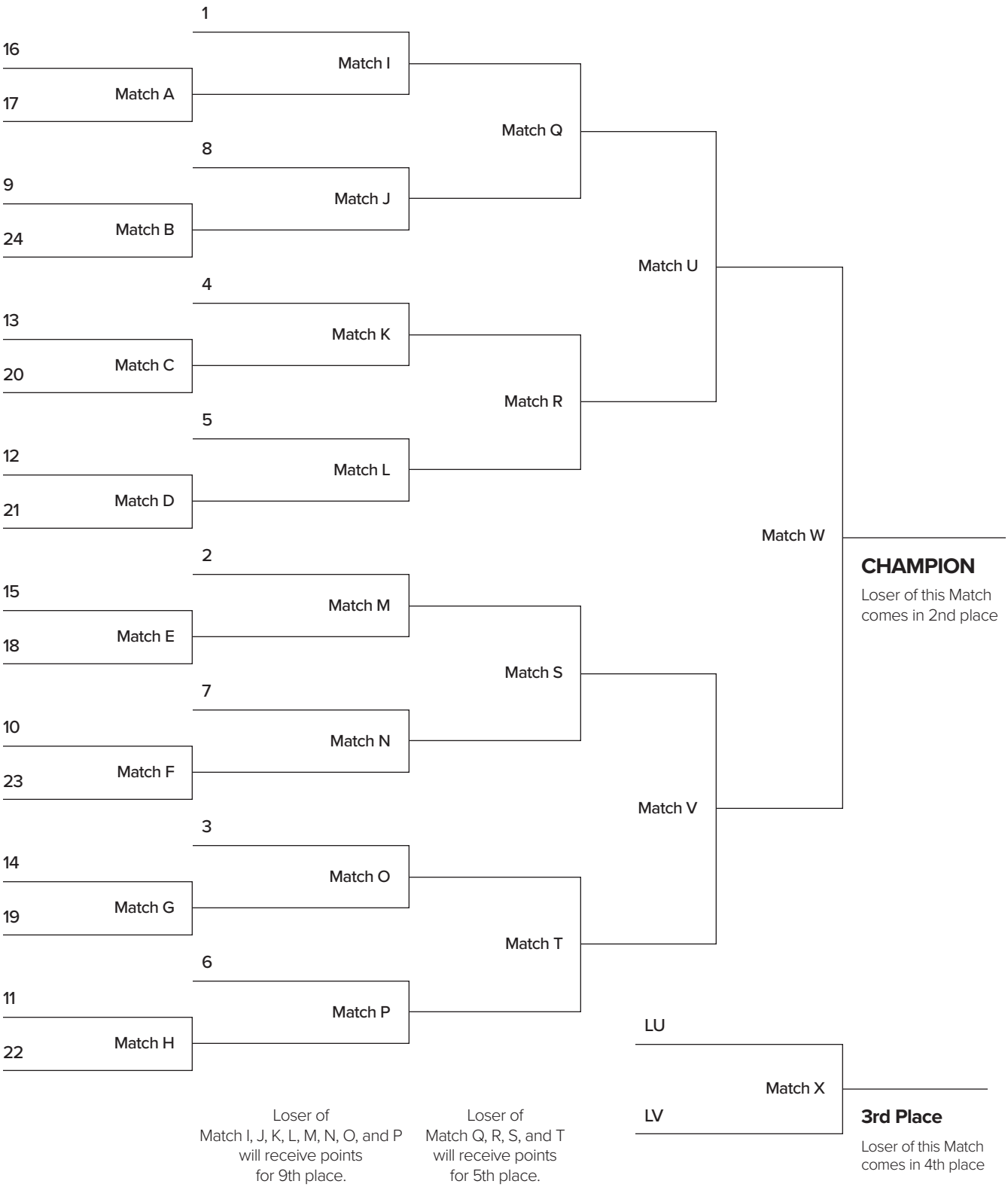
Part	Description	Purchased or Recycled	Cost
		TOTAL	

RUN LOG

RACE CAR NAME:			
Race #	Time	Battery or Solar	Notes
#1			
#2			
#3			
#4			
#5			
#6			
#7			
#8			
#9			
#10			

HEAD-TO-HEAD BRACKET

Tournament Bracket Seeded 24 Team Field



Participant/Team ID# _____

HYBRID RACER XL

2027 & 2028 OFFICIAL RATING FORM

HIGH SCHOOL

Judges: Using minimal (1-4 points), adequate (5-8 points), or exemplary (9-10 points) performance levels as a guideline in the rating form, record the scores earned for the event criteria in the column spaces to the right. The X1 or X2 notation in the criteria column is a multiplier factor for determining the points earned. (Example: an "adequate" score of 7 for an X1 criterion = 7 points; an "adequate" score of 7 for an X2 criterion = 14 points.) A score of zero (0) is acceptable if the minimal performance for any criterion is not met.

Go/No Go Specifications

- Before judging the entry, ensure that the items below are present; indicate presence with a check mark in the box.
- If an item is missing, leave the box next to the item blank and place a check mark in the box labeled ENTRY NOT EVALUATED.
- If a check mark is placed in the ENTRY NOT EVALUATED box, the entry is not to be judged.

☐ TIER 1 – Dual-car model present with student made attachment device
☐ TIER 2 – Showcase display and documentation portfolio is present
☐ ENTRY NOT EVALUATED

TIER 1 – TIME TRIALS		
Fastest Duration Time	Seconds	
	TIER 1 – TIME TRIALS TOTAL (Seconds)	

Rules violations (a deduction of 20% of the total combined time trials for the above sections) must be initialed by the judge, coordinator, and manager of the event. Record the deduction in the space to the right.

Indicate the rule violated: _____

TIER 1 – SUBTOTAL (Seconds)	

TIER 2 – SHOWCASE DISPLAY AND MODEL (110 points)				Record scores in the column spaces below.
CRITERIA	Minimal performance	Adequate performance	Exemplary performance	
	1-4 points	5-8 points	9-10 points	
Display Components (X1)	A number of display components are missing.	Most of the display components are included, but the quality is minimal.	Display includes all required components in order; it is neat and properly organized; effort and quality are evident.	
Engineering Design Process (X2)	Engineering Design Process is not defined or is lacking significant portions; it is messy and demonstrates lack of effort.	Engineering Design Process is acceptable, with most information included.	Engineering Desing Process is complete and accurate; information is neat and orderly; a great deal of effort is evident.	
Design Drawings (X1)	Some drawings are missing and/or drawings are of poor quality.	Drawings are acceptable; all required views are shown.	Drawings are accurate and complete; all required views are present; rough sketches are included.	

TIER 2 – SHOWCASE DISPLAY AND MODEL (110 points) – continued				
Videos using QR Code (X1)	QR code is not included or the videos are not accessible.	QR code is present and one (1) to two (2) videos are provided as evidence of model car running on solar power alone.	QR code is present and three (3) videos are provided as evidence of model car running on solar power alone.	
Model Design (X2)	Design of the solar model is poor and shows little effort.	Design of the solar model is adequate but not of exceptional quality.	Design of the solar model exhibits exceptional quality.	
Model Creativity/ Originality (X2)	Solar model car design lacks creativity and originality; little effort is apparent; car is an exact, or nearly an exact replica of purchased kit.	Solar model car design demonstrates an adequate level of creativity and originality; at least one (1) modification has been made to the car.	Solar model car design shows exceptional creativity, originality, artisanship, and engineering.	
Model Construction (X2)	Solar model car lacks quality of construction.	Solar model car demonstrates adequate quality of construction.	Solar model car demonstrates exceptional quality of construction.	
			TIER 2 – SHOWCASE DISPLAY AND MODEL SUBTOTAL (110 points)	

TIER 2 – DOCUMENTATION PORTFOLIO (40 points)				Record scores in the column spaces below.
CRITERIA	Minimal performance	Adequate performance	Exemplary performance	
	1-4 points	5-8 points	9-10 points	
Portfolio Components (X1)	Portfolio is unorganized and/or is missing three (3) or more components.	Portfolio has most components and is generally organized per the order of the event guide listing; it has sufficient content.	All components are included in the portfolio; content and organization per the order of the event guide listing are excellent.	
Design Details/ Components List (X1)	Several details of the model, such as model size, wheel size, and gear ratio are missing and/or are poor; components list is very limited.	Most details of the model, such as model size, wheel size, and gear ratio are included; most components are included.	All details of the model, such as model size, wheel size, and gear ratio are present; all components are included.	
Run Log (X1)	No Run Log created or less than five (5) runs recorded.	Run Log created with multiple runs but little detail related to performance and adjustments.	Run Log included with multiple runs and detailed information about performance, variables and adjustments.	
Resources and AI Reflection (X1)	Form is incomplete or vague and does not clearly explain whether or how AI was used, showing little connection to the submission or understanding of effectiveness and ethics.	Form is complete and clearly explains AI use or the lack thereof with connections to the submission or theme/topic (when applicable), addressing effectiveness and ethical considerations with adequate analysis.	Form is complete, concise, and specific, critically evaluating how AI or non-AI tools shaped decisions and outcomes, with strong alignment to the submission or theme/topic (when applicable) and ethical reasoning.	
			DOCUMENTATION PORTFOLIO SUBTOTAL (40 points)	

TIER 2 – HEAD-TO-HEAD RACE (80 points)						
Points are assigned based on results from double elimination bracket.						
1st	2nd	3rd & 4th	5th – 8th	9th – 16th	17th – 24th	
80 Points	75 Points	70 Points	60 Points	50 Points	40 Points	
					SEMIFINAL RACE SUBTOTAL (80 points)	

Rules violations (a deduction of 20% of the total possible points for the above sections) must be initialed by the judge, coordinator, and manager of the event. Record the deduction in the space to the right. Indicate the rule violated: _____	
PRELIMINARY TOTAL (230 points)	

SEMIFINAL CAR BUILDER INTERVIEW (40 points)				Record scores in the column spaces below.
CRITERIA	Minimal performance	Adequate performance	Exemplary performance	
	1-4 points	5-8 points	9-10 points	
Car Builder Interview (X2)	Team shows very limited knowledge of (and has difficulty articulating) how the car was produced or decisions made during the production; student exhibits a basic understanding of design elements and functionality, and the rationale is inconsistent or absent.	Team demonstrates some knowledge of the vehicle production and has adequate knowledge of some processes or reasoning behind the vehicle design.	Team shows competence and knowledge related to the design and production of the vehicle; student is able to articulate "reasoning" behind the decisions made.	
Articulation (X2)	Communication of the design process is unclear, unorganized, and or illogical; leadership and/or 21st century skills are not evident.	Communication of the design process is somewhat logical and clear; leadership and/or 21st century skills are somewhat evident.	Communication of the design process is clear, concise, and logical; leadership and/or 21st century skills are clearly evident.	
SEMIFINAL CAR BUILDER INTERVIEW SUBTOTAL (40 points)				

Rules violations (a deduction of 20% of the total possible points for the above sections) must be initialed by the judge, coordinator, and manager of the event. Record the deduction in the space to the right. Indicate the rule violated: _____	
SEMIFINAL TOTAL (40 points)	
To arrive at the FINAL TOTAL score, subtract rules violation points, as necessary. **TOTAL** (270 points)	

Comments:

I certify these results to be true and accurate to the best of my knowledge.

JUDGE

Printed name: _____ Signature: _____

HYBRID RACER XL
EVENT COORDINATOR INSTRUCTIONS

PERSONNEL

A. Event coordinator
B. Judges, two (2) or more for preliminary round
C. Judges, two (2) or more for semifinal round (can be the same judges as preliminary round)
D. Assistants, six (6) or more

MATERIALS

A. Coordinator's packet containing:
    1. Event guidelines, one (1) copy for the coordinator and for each judge
    2. TSA Event Coordinator Report
    3. Stick-on labels for identifying entries
B. Race bracket form
C. Interview questions
D. Batteries (AA 1.5 V), two (2) per entry plus spares on-site
E. Braided fishing line for the track:
    1. Four (4) pre-tied
    2. Two (2) on track
F. One (1) LED solar lamp (one-hundred [100] watt equivalent bulb minimum)
G. Race track set, including a starting gate and finish gate with digital timer
H. Spare stopwatches for back-ups
I. Padding for the finish gate
J. Tables for the display and evaluation of entries (cars and portfolios)
K. Lane Assignment Board to be used for a display of semifinals racing
L. Tables and chairs for event coordinator, judges, and official assistants
M. A large display for the final twenty-four (24) bracket
N. A gauge to measure line height at the beginning and end of the line

RESPONSIBILITIES

AT THE CONFERENCE

A. Attend the mandatory event coordinator's meeting at the designated time and location.
B. Report to the CRC room and check the contents of the coordinator's packet.
C. Review the event guidelines and check to see that enough personnel have been scheduled.
D. Inspect the area(s) in which the event will be held for appropriate set-up, including location for displays and the evaluation of portfolios, racing site, chairs, tables, outlets, etc.
E. At least one (1) hour before the event is to begin, meet with judges and assistants to review time limits, procedures, regulations, evaluation, and all other details related to the event. If questions arise that cannot be answered, speak to the event manager before the event begins.
F. Ensure the judges have access to the online judging system.

PRELIMINARY ROUND

A. Participants report to the time and place stated in the conference program and check in:
    1. Solar-powered model car and decorated shoebox
B. Secure the entries in the designated area.
C. Requirements for attire do NOT apply during check-in, only on the first day of the conference.
D. Late participants and/or entries are considered on a case-by-case basis and only when lateness is caused by events beyond the participant's control.
E. In order to compete, participants must be on the entry list or must have approval of the CRC.
F. Position the displays and models for viewing by the judges, and assist them as necessary during judging.
G. Set up the race track prior to the time trials. Make necessary adjustments.
H. Complete the solar power test using the solar lamp to verify the solution will operate using solar power.

I. Permit all vehicles (that can be safely operated) to participate in time trials.

J. Vehicles that are disqualified will NOT be permitted to participate in the time trials or head-to-head races.

K. Decisions about rules violations must be discussed and verified with the judges, event coordinator, and the CRC manager to determine either:

   1. To deduct twenty percent (20%) of the total possible points in this round
   2. To disqualify the entry

   The event coordinator, judges, and CRC manager must initial either of these actions on the rating form.

L. Judges evaluate the showcase display and models of the top twenty-four (24) entries.

M. Complete the head-to-head races using the single elimination bracket at the time and location printed in the conference program.

N. Only the twenty four (24) qualifying cars will race.

O. Public viewing is allowed.

P. If necessary, manage the security and removal of materials from the event area.

SEMIFINAL ROUND

A. Semifinalists report to sign-up for the interview at the time and place stated in the conference program. Instruct the teams to arrive at least ten (10) minutes prior to their interview time.

B. Check in semifinalists and confirm with the teams their order of interviews and the procedure. Team representatives should report at least ten (10) minutes prior to their assigned time to the designated place for their interview.

C. Manage the interviews.

D. Discuss rule violations and have all relevant parties initial the rating form.

E. Judges independently assess the semifinal interviews.

F. If necessary, manage security and the removal of materials from the event area.