



## CO<sub>2</sub> Cars

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### Event Overview

Applying leadership and 21<sup>st</sup> century skills, participants design and produce a race-worthy CO<sub>2</sub>-powered car according to stated specifications, using only specified materials. Students will work to develop their leadership and 21<sup>st</sup> century skills in the process of preparing for and participating in the event. The development and application of those skills must be evident in their submission and demonstration pertaining to the entry.

Each participant is limited to a single entry for the competition.

Each entry must include both the CO<sub>2</sub> Car and the required documentation, which will be submitted upon check-in per the conference Day of Timeline.

The host district will provide all CO<sub>2</sub> Cartridges.

The official distance between the start line and the finish line on the racetrack is twenty (20) meters.

Participants check in the following at the registration table at the time stated in the Day of Event Timeline.

1. The CO<sub>2</sub> Car
2. A full-size two (2)-view (bottom and side) technical drawing
3. A letter-size listing of all parts and materials used in the construction of the car is affixed to the back of the technical drawing.

### Competitors

Participants will compete individually.

#### Competitors Must Bring:

- Finished CO<sub>2</sub> Car
- A full-size two (2)-view (bottom and side) technical drawing
- A letter-size listing of all parts and materials used in the construction of the car affixed to the back of the technical drawing

### Competition

#### Pre-Conference:

1. Students must design, construct, and finish their car while working within the required specifications.
2. One entry per student.
3. Student may use any materials that meet specifications or a Whitebox Learning CO<sub>2</sub> Car kit.

4. All cars must be completed before racing (no wet paint).
5. Student cannot adjust or modify their car after registration and check-in.
6. Each entry must be submitted at check-in with a full-size metric drawing and a completed vehicle's materials list.
7. A two (2)-view (bottom and side) technical drawing with metric dimensions must be made on 11" x 17" drawing paper.
8. The drawing must be developed using standard engineering practices and procedures; it may be produced using traditional drafting methods or CAD.
9. The title block includes the student's name and school.

## Specifications

*Technology Student Association (TSA) Middle School Competitive Events Specifications are used for safety precautions.*

Car Body	Minimum	Maximum
1. One (1)-piece, construction of wood or plastics, including urethan modeling foam <ol style="list-style-type: none"> <li>a. Two (2) or more like or unlike pieces of material glued together are not considered one (1)-piece</li> <li>b. Any type of lamination will result in disqualification.</li> <li>c. No add—ons, such as body strengtheners, fenders, plastic canopy, exhausts, or air foils, may be attached to or enclosed within the vehicle. Hydro dipping technique is permitted.</li> <li>d. Fiberglass, vinyl wrap, and shrink wrap are considered body strengtheners and cannot be used on the car body for any reason.</li> <li>e. Decals may be used for decoration only; they may not be used to gain an aerodynamic advantage, i.e., decals cannot cover the exterior axle holes or be used to cover open areas of the body.</li> </ol>		
2. Body length	200mm	305mm
3. Body height with wheels		75mm
4. Body mass (completed car without CO <sub>2</sub> )	65g	170g
5. Body width at the point the axles pass through the body, front and back	35mm	42mm
6. Vehicle total width (including wheels)		80mm
Axles/axle holes/wheelbase	Minimum	Maximum
1. Axle Diameter (only two allowed)	3mm	3mm
2. Axle Length	42mm	70mm
3. Axle Bearings Diameter	3.5mm	4.5mm
4. Axle Hole Diameter	3.5mm	4.5mm
5. Axle Hole position from either end of body	9mm	100mm
6. Axle Hole (position above bottom of car)	5mm	10mm

7. Spacer Bearing Diameter	7mm	9mm
<b>Spacer washer/clips</b>	<b>Minimum</b>	<b>Maximum</b>
1. Spacer washers		10
2. Axle clips		4
3. Silicone or any other type of glue/adhesive may not be used in place of wheel clips to hold wheels or axles in place.		
<b>Power plant (CO<sub>2</sub> cartridge hole)</b>	<b>Minimum</b>	<b>Maximum</b>
1. The power plant hole must be at the farthest point at the rear of the car and must be drilled parallel to the racing surface to ensure proper puncture of the CO <sub>2</sub> cartridge. <ul style="list-style-type: none"> <li>a. A minimum of 5mm thickness around the entire power plant hole must be maintained on the car for safety.</li> <li>b. There should be no paint inside the CO<sub>2</sub> cartridge hole.</li> </ul>		
2. Hole depth	50mm	52mm
3. Safety zone thickness		3mm
4. Chamber diameter	19mm	20mm
5. Lowest point of chamber diameter to race surface (with wheels) - Power Plant Center Line from body bottom	31mm	35mm
<b>Eye screws</b>	<b>Minimum</b>	<b>Maximum</b>
1. Car must have no more than two (2) eye screws per car that meet tolerances. <ul style="list-style-type: none"> <li>a. Eye screws must not make contact with the racing surface.</li> <li>b. The track string must pass through both eye screws, which are located on the center line of the bottom of the car.</li> <li>c. Eye screws may be glued in place with CA glue or epoxy.</li> <li>d. It is the responsibility of the car designer/engineer to see that the eye screw holes are tightly closed to prevent the track string from slipping out.</li> <li>e. Any adjustments must be made prior to event check-in.</li> </ul>		
2. Inside diameter	3mm	5mm
3. Distance apart (at farthest points)	155mm	270mm
<b>Wheels</b>	<b>Minimum</b>	<b>Maximum</b>
1. A car must have exactly four (4) wheels, each of which separately must meet regulations in items 2 and 3 below. <ul style="list-style-type: none"> <li>a. All four (4) wheels must touch the racing surface at the same time.</li> <li>b. All wheels must roll.</li> <li>c. Wheels must be made entirely from plastic.</li> <li>d. Dimensions must be consistent for the full circumference of the wheel.</li> </ul>		
2. Wheels, Front Diameter	32mm	37mm
3. Wheels, Front Width of greatest diameter	2mm	5mm
4. Wheels, Rear Diameter	30mm	40mm

5. Wheels, Rear Width of greatest diameter	15mm	18mm
6. Wheel Base	105mm	270mm

### Race Day Procedure

1. Entries will be reviewed by contest officials to determine specification compliance and safety on the track.
2. Vehicles that do not meet guideline specifications but do meet the power plant/CO<sub>2</sub> cartridge hole requirement and are deemed safe to race will be raced. They will receive a 3-point deduction in the overall score.
3. All cars will be expected to race.
4. Cars will be raced by an adult for safety.
5. Safe vehicles will race for two (2) qualifying times, one on each lane of the raceway. The average of the two times will determine the top 10 cars.
6. Students with the top 10 cars will participate in a 5-minute interview with judges.
7. Final points will be tallied, and awards will be given based on the rubric.
8. After the award session, participants will pick up their entries from the registration area.

### Final Scoring

Final rank is determined based on the construction of the CO<sub>2</sub> car, technical drawing and material list, participant interview, and average race result. The fastest race time will be used to determine the rank in a tie.

# CO<sub>2</sub> CAR Judge Rating Sheet

Student Name \_\_\_\_\_

Judge's Signature \_\_\_\_\_

CRITERIA	Exemplary performance	Adequate performance	Minimal performance	Points
	<i>7-10 points</i>	<i>4-6 points</i>	<i>0-3 points</i>	
<b>CO<sub>2</sub> Car Body Production Quality</b>	Excellent production techniques are displayed in the car; obvious attention to detail and quality is evident.	Car shows evidence of proper production techniques; car is adequate but needs improvement.	Car exhibits poor production quality; little or no attention to detail is evident; surface is crude and rough.	
<b>Body Paint/Finish</b>	Car body finish is exemplary; body is smooth, shiny, and exhibits creative paint layouts and details.	Car body is painted and finished but is of average quality; body surface is inconsistent.	Surface preparation is inadequate; body is unprimed, with poorly applied final finish. Body is rough; paint is rough or sticky.	
<b>Vehicle Assembly</b>	Car is properly assembled, with obvious evidence of attention to detail, showing ingenuity.	Car is adequately assembled; meets standards.	Car exhibits poor or sloppy assembly of parts (loose wheels, eye screws are not level, and/or they are loose, etc.).	
<b>Drawing Scale and Dimensioning</b>	Drawing is exemplary, exact, and includes all pertinent dimensions.	Drawing is acceptable, true to scale, and it is a close representation of the vehicle; some dimensions are missing.	Drawing is present but is not to scale; dimensions are missing, or dimensioning is poorly done.	
<b>Materials List</b>	Materials list is complete and detailed.	Materials list is present and lists the majority of parts.	Materials list is not complete.	
<b>Car Construction Subtotal (50 possible points)</b>				

Race Time	Race Time 1	Race Time 2	Composite Time (Time 1 + Time 2)/2	Points (Composite Time)

Interview	Exemplary performance	Adequate performance	Minimal performance	Points
	<b><i>7-10 points</i></b>	<b><i>4-6 points</i></b>	<b><i>0-3 points</i></b>	
Car Builder Interview	The participant shows competence and knowledge related to the design and production of the vehicle; the participant is able to articulate “reasoning” behind the decisions made; leadership and/or 21 <sup>st</sup> century skills are clearly evident.	The participant demonstrates knowledge of the car production and has adequate knowledge of some processes or reasoning behind the vehicle design; leadership and/or 21 <sup>st</sup> century skills are somewhat evident.	The participant shows very limited knowledge of (and has difficulty articulating) how the car was produced or decisions made during the production; the participant exhibits a basic understanding of design elements and functionality, and the rationale is inconsistent or absent; leadership and/or 21 <sup>st</sup> century skills are not evident.	

<b>TOTAL POINTS</b>	
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