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## ELECTRIC VEHICLE

1. **DESCRIPTION:** Contestants will construct a "vehicle" which uses electrical energy as its sole means of propulsion. They should be able to adjust the vehicle to travel a distance specified by the judges and to predict the time it will take to travel that distance.

**A TEAM OF UP TO:** 2

**IMPOUND:** Yes

**APPROXIMATE TIME:** 10 minutes

2. **CONSTRUCTION:**

- Vehicles should be designed to travel between 5 and 10 meters and come to a complete stop without straying from the track's center.
- All energy used to propel the vehicle must be stored in common, commercially available, batteries labeled with their voltage by the manufacturer. Batteries must be impounded with the vehicle, but they need not be installed until immediately prior to the run. A maximum of 8 individual cells (rated at 1.5 volts or less each) or 2 battery packs (rated at 4.8 volts or less each) may be impounded with the vehicle. The vehicle may use no more than 4 individual cells or a single battery pack at one time. **All sources of power shall be in a location as to be available for inspection and/or measurement by the event supervisor.**
- Additional energy storage devices may be used to operate other functions (e.g., braking system) provided they do not store energy that helps to propel the vehicle in any way.
- Components may be purchased or made by the contestants (e.g., motors, gearboxes, chassis, motor controls, transistors, diodes, etc.). Electronic aligning/sighting devices, including lasers, are not allowed.
- The vehicle's wheel base (distance measured parallel to the direction of travel between the center of rotation of the front and rear axles) must be 40 +/- 3 cm and the vehicle's track/width (distance measured perpendicular to the direction of travel between the outermost side of the left tire and the outermost side of the right tire of the vehicle's widest axle) may not exceed 25 cm.
- The vehicle must have a stationary, pointed object, such as a toothpick, extending forward of all other parts of the vehicle (including the wheels) and to within 1 cm of the track's surface. The tip of this pointer nearest the track surface will be used as the reference point on the vehicle for all distance measurements. All aligning devices must be permanently attached in a fixed position and travel with the vehicle.
- Contestants may not touch the vehicle to start it. They must use a pencil, pen or wooden dowel (which is not part of and does not travel with the vehicle) to actuate some sort of switch. They may not "push" the vehicle to get it started. The entire vehicle, including batteries, must move forward together.
- The braking system (except for the vehicle's wheels) may not contact the floor or tape defining the track.
- Only the impounded batteries may be removed from/added to the vehicle.

3. **THE TRACK:**

- The track will be on a smooth, level, and hard surface. Space is needed on each side of the track's center and beyond the finish line to allow for error in the vehicle's path.
- 3/4 or 1 inch tape will be used to define the track's center, the Starting Line, and Target Distance (finish line). The inside edge of the tape will define the Starting Line and the Target Distance. The start and finish lines should extend as far as practical on either side of the track's center.
- At the event supervisor's discretion, more than one track may be used. Teams will be given the option to choose which track they will use. All runs by a team will be made on the same track.

4. **THE COMPETITION:**

- All vehicles and batteries must be impounded before the start of the competition. Tools, data and calculating devices need not be impounded.
- Teams may remove their vehicle once they finish competing however; if they wish to file an appeal they may not retrieve their vehicle without permission from the appeals committee. Once they have taken their vehicle they may not file an appeal.
- The exact Target Distance (in 0.5-meter intervals for regional, 10 cm intervals for state and 1 cm intervals for national tournaments) will be chosen by the judges and will not be announced until all vehicles have been impounded on the day of the competition.
- Only contestants and judges will be allowed in the impound area and track areas while teams are competing. Contestants may bring tools for adjusting vehicle, test data and electronic calculating/computing devices to assist in making accurate time/distance predictions.
- The contestants will predict a time of 45 seconds or less that the vehicle will take to travel the Target Distance. The Predicted Time may not be changed for the second run, but the vehicle may be adjusted.  
**National Tournament only:** The event supervisor will choose **both** a Target Distance and a Target Time,

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between 1.5 and 4 seconds per meter (i.e., 15-40 seconds for a 10 meter Target Distance), and the contestants must adjust their vehicle to travel the Target Distance as nearly as possible to that Target Time.

- f. Teams will be given 10 minutes to perform the following actions and complete up to 2 runs. Vehicles will be permitted to complete a run if they are in motion before the end of the 10-minute time period.
  - i. Adjust their vehicle before each run (e.g., change its speed, distance and directional control).
  - ii. Use their own measuring devices to verify the track dimensions. They may not verify the distance by rolling the vehicle on the track surface (floor) between the start and finish line at any time prior to or during the competition.
  - iii. Place the tip of the vehicle's pointer even with the Starting Line and align the vehicle. A target may be placed at the finish line to aid in aligning the vehicle, but must be removed before starting each run.
  - iv. Use the pencil, pen, or wooden dowel to actuate the switch on the vehicle to begin the run. Actuation of the switch will be considered a run, whether or not the vehicle moves.
  - v. Time used by judges for measuring will not be included in the 10 minutes.
5. **SCORING:** The Run Score will be the sum of 4 components: the Distance Score, the Time Score, the Finish Line Score, and the Center Line Score. The minimum for each score component will be zero (0).
  - a. The Distance Score will be the Target Distance minus the absolute value of the difference between the Target Distance and the Distance Traveled divided by the Target Distance multiplied by 100. These distances are measured in meters. The Distance Traveled is measured from the Starting Line to the tip of the vehicle's pointer, perpendicular to the Starting Line (point-to-line distance).

$$\text{Distance Score} = \frac{\text{Target Distance} - |\text{Target Distance} - \text{Distance Traveled}|}{\text{Target Distance}} \times 100$$

- b. The Time Score is the Predicted Time minus the absolute value of the difference between the Predicted Time and Measured Time divided by the Predicted Time, multiplied by 50. All times are measured in seconds. The Predicted Time must be less than 45 seconds. The Measured Time will start when the switch is actuated and stops when the tip of the pointer crosses the finish line or the first time forward motion of the vehicle stops, whichever occurs first. At **Nationals** the **Predicted** Time will be the announced **Target** Time.

$$\text{Time Score} = \frac{\text{Predicted Time} - |\text{Predicted Time} - \text{Measured Time}|}{\text{Predicted Time}} \times 50$$

- c. Up to 40 Finish Line Score points will be awarded based on the Final Distance, measured from the center of the finish line (the point where the center of the track's center tape and the finish line intersect) to the tip of the pointer on the vehicle. The Final Distance is measured in centimeters within a 40-centimeter radius circle. Direct straight-line (point-to-point) measurements will be used.

$$\text{Finish Line Score} = 40 - \text{Final Distance (cm)}$$

- d. A Center Line Score of 10 points will be awarded if the center tape remains completely within the vehicle's track between the start line and the finish line. This bonus will be awarded even if the pointer or the entire vehicle crosses the finish line.
- e. The final score for the event will be the highest of either total score. A vehicle/team that violates any rule requirement will be ranked by their final score in a second tier below all vehicles/teams that do not violate the rules.
- f. Ties will be broken first in favor of the contestants with the better Time Score and if a tie still exists, in favor of the better Distance Score.

**Scoring Example:** The contestants predict it will take 5.9 sec. to travel 9 meters. Measured Time: 7.45 sec. Distance Traveled: 8.85m. Distance from the center of the finish line to the tip of the pointer = 20 cm. Vehicle stayed on the track's center tape.

<b>Distance Score</b>	<b>98.33 pts.</b>	$[(9 -  9 - 8.85 ) / 9] \times 100 = 98.33 \text{ pts.}$
<b>Time Score</b>	<b>36.86 pts.</b>	$[(5.9 -  5.9 - 7.45 ) / 5.9] \times 50 = 36.86 \text{ pts.}$
<b>Finish Line Score</b>	<b>20 pts.</b>	$40 - 20 \text{ cm} = 20 \text{ pts.}$
<b>Center Line Score</b>	<b>10 pts.</b>	
<b>Run Score</b>	<b>165.19 pts.</b>	$98.33 + 36.86 + 20 + 10 = 165.19 \text{ pts.}$



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