ELECTRIC VEHICLE C

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Teams design, build, and test one vehicle that uses electrical energy as its sole means of propulsion to travel in a set amount of time, push a bottle past a line, and move backwards to stop close to a Target Point.

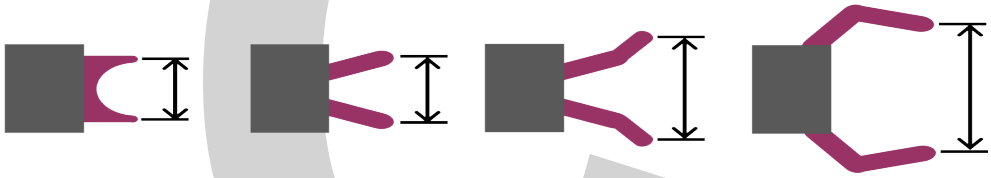
   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 12 minutes

   IMPOUND: Yes

2. **EVENT PARAMETERS:**
   a. Vehicle will be designed and built by the team prior to the competition.
   b. Impound: Team must impound before the first time slot.
   c. Event Time: Teams will each have 8 minutes to adjust, repair, and run their Vehicle.
   d. Track: The Event Supervisor will provide and set up the Track as listed in the Track section.
3. **CONSTRUCTION PARAMETERS:**
   a. Electrical Energy used by the Vehicle for any purpose must come from a maximum of eight (8) AA batteries.
      i. No battery containing lithium or lead acid is permitted. Teams using these batteries will not be permitted to run and will receive only participation points.
      ii. Energy storage methods which allow teams to exceed the instantaneous energy available from the batteries are not allowed. An example would be large capacitors or a spring.
      iii. Electronic sighting, alignment, or aiming devices may have their own separate power source. Lasers are prohibited.
      iv. All sources of energy must be in easily accessible locations for inspection by the ES.
   b. Propulsion Energy: must be electric and come from the AA batteries.
   c. Components may be purchased or made by the team members. Electronic components are allowed.
      i. If a microprocessor is used, students may communicate with their device over WiFi, Bluetooth, or USB.
   d. **Vehicle Length: The Vehicle length including all components must not exceed 80.0 cm.**
   e. Vehicle Width: The Vehicle width must not exceed 35.0 cm at any point.
   f. **Bottle Pusher: A device to catch and push the Water Bottle must be attached to the front of the Vehicle. The Pusher must be the foremost part of the Vehicle. Only one Bottle Pusher can be impounded. The Pusher must be rigid, cannot flex, change locations on the Vehicle, have moving parts, or have the ability to change in size. The Pusher's foremost edge(s) must have rounded edge(s) approximately the diameter of #2 pencil or larger. The Pusher must be able to move bottles not perfectly round. The Bottle does not need to fully fit inside the Bottle Pusher.**
   g. Measurement Point: The Vehicle must have a Measurement Point (MP) for distance measurements at the **rear** of the Vehicle. **The MP must be the rear most part of the Vehicle.**
   h. Remote Control: The Vehicle must not be remotely controlled or tethered.
   i. Vehicle Parts: All parts of the Vehicle must move as a whole: no anchors, tethers, tie downs, launching ramps, or other separate pieces are allowed. The only parts allowed to contact the floor during the run are wheels/treads, and any parts already in contact with the floor in the ready-to-run configuration. Pieces falling off during the run constitutes a Construction Violation.
   j. Design Knowledge: Answer questions on design, construction, and operation of the device per the Building Policy found on www.soinc.org.
   k. **Purchased Kits or Open Source Kits are allowed for this event with the following requirements:**
      i. **Teams must make at least two functional modifications to the kit during the build process. These modifications need to be documented on the Kit Modification Form available on soinc.org. The completed form must be impounded.**
      ii. **A Bottle Pusher from kit sources cannot be used. Teams must design and build their own Bottle Pusher.**
      iii. **A kit (supplier or open source) can only provide components if these components are common parts available from other sources (e.g. no custom printed circuit boards). This does not include parts that are 3D printed plastic parts.**
      iv. **Teams violating rules 3.k.i. through 3.k.iii. will receive the Non-modification Penalty to their Run Scores.**

l. **The program must be developed by at least 1 member of the 15 member team. Teams may use skeleton or blank shell programs from the Internet or another competitor from the same school as their starting point. Teams may download small code sections or examples from the Internet to develop the larger completed program for their device. Single-source programs are prohibited. Teams will receive a construction penalty for violating this rule.**

4. **THE COMPETITION:**
   a. **Impound before first time slot.**
      i. Teams must impound one Vehicle, batteries, spare parts, alignment device (if used), **Kit Modification Form** (if used), and any papers (if used).
      ii. Batteries must be stored separately from Vehicle and presented to ES for inspection if asked. Teams will be allowed to correct if an issue is found.
      iii. Tools do not need to be impounded.
      iv. Inspections will NOT take place during impound as any of the 15 member team may impound.
   b. **After Impound** and before the first time slot, the Target Distance, Target Time, **and Bottle Line Distance** will be announced and posted. All posted values at a competition will be the same for all teams.
   c. **Check-In**
      i. Only the participants will enter and may bring tools as defined.
      ii. Teams will be instructed by the ES when to retrieve their impounded items.
      iii. Teams will present their Vehicle for inspection and measurement by the ES. Participants will be notified at this point if any construction violations are found.
         (1) A construction violation will be awarded to all runs if more than one Vehicle was impounded.
         (2) Teams may use their Event Time to correct any construction violations. A team's Event Time will be paused during re-evaluation by the ES.
      iv. **ES will measure, to the nearest 0.1 cm, the widest opening of the Bottle Pusher (See diagram below). Teams without a designated Bottle Pusher will use 35.0 cm for the measurement.**



      v. Once participants start the Check-In process, they must not leave or gain any outside assistance or materials until their Event Time is completed.
      vi. Participants may not use an AC outlet power during their time slot.
      vii. **Any type of AI cannot be used by the participants or the device during the team's event time. AI tools may be used to assist with designing or programming the device prior to the day of the competition.**
   d. Event Time
      i. The Event Time ends after 2 runs or the time limit has been reached. Teams may adjust their Vehicle (e.g., repair, wiring, change distance, aiming) within their Event Time.
         (1) The time limit for the Event Time is 8 minutes.
         (2) The ES will notify the participants when their Event Time starts.
         (3) Vehicles in the ready-to-run configuration before the end of the Event Time will be allowed to complete a run.
      ii. Sighting, aligning, measurement, and guiding devices, if used, must be placed and used within the defined Track area. **Device(s) cannot be secured to the floor of the track area. Alignment devices can be shared by teams from the same school.** If placed on the Vehicle, they may be removed at the team's discretion. Devices remaining on the Vehicle will be considered part of the Vehicle. All items not part of the Vehicle must be moved and placed behind the Start Point prior to starting a run. Sighting, aligning, and guiding devices may use electricity. Lasers are prohibited.
      iii. Teams may use their own tools to verify the Track dimensions during their Event Time.
      iv. Substances applied to the Vehicle must be approved by the ES prior to use and must not damage or leave residue on the floor, Track and/or event area. Teams may clean the Track during their Event Time, but it must remain dry. **Competitors are not allowed to use tape on the event floor.**



v. Teams may access the Internet to program their Device. Any actions not required for programming will cause a team to be awarded a competition violation. Internet access may not be available at all competitions.
vi. Teams must not roll or test the Vehicle on the floor of the Track on the day of the event **or prior day** without tournament permission. If permitted, only participants may be present. During competition, teams must not roll the vehicle on the floor before or after runs.
vii. Individual Run Testing
(1) Participants must place the Vehicle's MP above the Start Point **within approximately 1 cm. The Vehicle's body must be placed in front of the Start Point (on the side toward the Target Point).**
(2) The Vehicle must be able to remain at the starting position without being touched until triggered.
(3) Participants will notify the ES when ready to start. At which point the ES will pause the Event Time and review the Vehicle in the Ready-To-Run configuration for any violations.
(a) The ES will only notify the participants of competition violations at the end of each run. Teams may ask question(s) before the run if there are specific violations. The ES will not answer generic questions like "Do I have a violation?"
(4) Participants will use a #2 unsharpened pencil to start the Vehicle using a vertical motion. Only the pencil may contact the Vehicle when triggered.
(a) If the Vehicle fails to actuate or move when triggered, then a run has not occurred. The Vehicle must move to be a measurable run. The participants may continue to work on their device provided they have not reached the end of their Event Time.
(5) Once the run starts and until the Vehicle is retrieved, competitors may not use, view, or access their programming tool(s).
(6) ES will review the run to determine if the run was Successful or a Failed Run.
(7) Run Time, Vehicle Distance, and Bottle Distance will be measured and recorded for Successful runs.
(8) **ES will verify the Moving Water Bottle Requirements were followed.**
(9) Competitors following their Vehicle down the track before being called to retrieve their vehicle, will receive a Competition Violation.
(10) All violations will be recorded. The ES must notify the participants of any violations at the end of each run.
(11) Timing resumes once the participants pick up their device or begin working toward the next run.
viii. The Event Supervisor will review with teams their data recorded at the end of their Event Time.
ix. Teams filing an appeal must leave their Vehicle and other impounded material in the event area.

5. **SCORING:**

a. Low Score wins.
b. Each team's Final Score is the better of the 2 Run Scores + Final Score Penalties.
c. Run Score = 100 + Distance Score + Time Score + Bonuses + Run Penalties
d. Distance Score = (2.0 pt/cm × Vehicle Distance) + **(1.0 pt/cm x Bottle Distance)**.
i. For a Failed Run, Distance Score is 2500.
ii. **If Water Bottle is not past Target Point or if the Moving Water Bottle Requirements are violated, then the Bottle Distance is equal to 400.0 cm.**
e. Time Score = Absolute value of (Target Time - Run Time) x 0.5 pt/sec
i. The Run Time will be recorded as 0.00 seconds for Failed Runs.
f. **Bottle Bonus = -20 points if the Water Bottle is fully beyond the Bottle Line**
g. **Pusher Bonus = (Pusher Foremost Opening Width – 35.0) x 1.5 pt/cm**
h. Event Time Bonus (National Only) = (Event Time Used − 480) / 30 points
i. **This bonus will only be applied to the Final Score.**
i. Run Penalties:
i. Competition Violation: 150 points added to the Run Score with one or more violations.
ii. Construction Violation: 300 points added to the Run Score with one or more violations.
iii. **Non-modification Penalty: 50 points added to Run Score.**
iv. Failed Runs can also be assessed Competition and/or Construction violations.



j. Final Score Penalties: Vehicle not Impounded: 5000 points added to the team's Final Score.
k. Two or more teams tied with 2 Failed Run scores, without Competition or Construction Violations, will remain scored as ties. Other ties are possible.
l. Tiebreakers in order: 1. Better **Distance Score** of the scored run; 2. Lower Time Score of the scored run; 3. **Better Vehicle Distance of the scored run**; 4. **Lower Bottle Pusher Measurement.**

6. **SCORING EXAMPLES:**
   a. A Vehicle has 2 Successful runs during the team's Event Time. Target time is 14 seconds. The Vehicle's Bottle Pusher had a Foremost Opening of 16.0 cm.
      i. In the 1st run, the Vehicle stopped 17.6 cm from the Target Point with a Run Time of 12.27 seconds. The Water Bottle was 10.6 cm from the Bottle Line but not past the line.
      ii. In the 2nd run, the Vehicle stopped 22.5 cm from the Target Point with a Run Time of 16.37 seconds. The Water Bottle was 12.1 cm from the Bottle Line and past the line.

Base Score	= 100	100.00
Distance Score	= 17.6 cm × 2.0 pts/cm + 10.6 cm x 1.0 pts / cm	45.80
Time Score	= abs(14 − 12.27) x 0.5 pts/sec	0.87
Bottle Bonus	= Not Beyond	0.00
Pusher Bonus	= (16.0 cm – 35.0) x 1.5 pts /cm	-28.50
1st Run Score		**118.17**

Base Score	= 100	100.00
Distance Score	= 22.5 cm × 2.0 pts/cm + 12.1 x 1.0 pts / cm	57.10
Time Score	= abs(14 − 16.37) x 0.5 pts/sec	1.19
Bottle Bonus	= -20.0 (Beyond)	−20.00
Pusher Bonus	= (16.0 cm – 35.0) x 1.5 pts /cm	-28.50
2nd Run Score		**109.79**

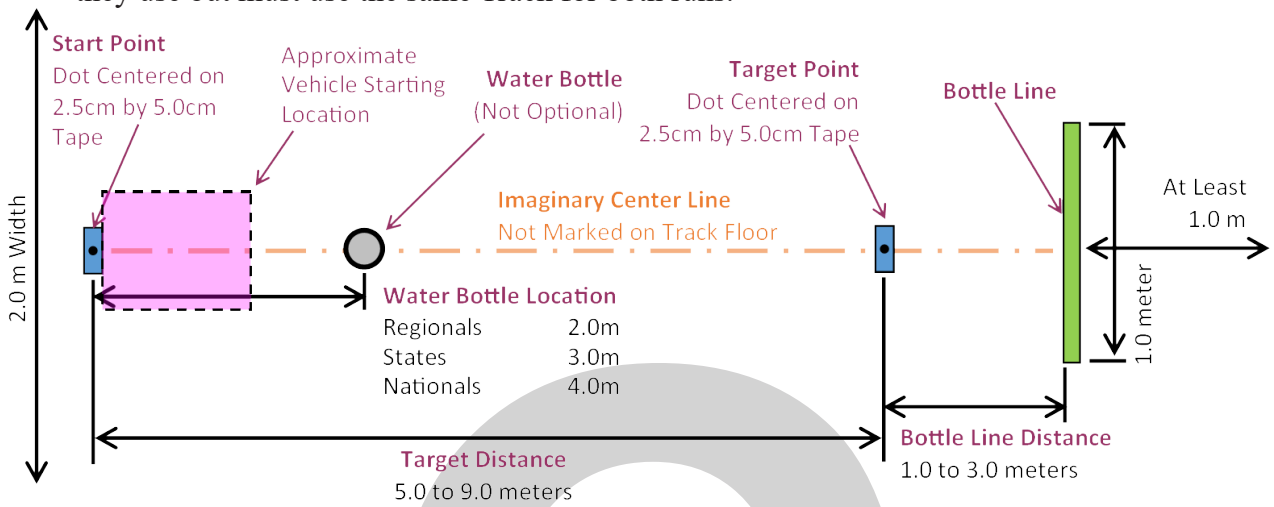
Final Score = 2nd Run Score (Better Score) = 109.79 pts

7. **THE TRACK:**
   a. In-Person tournaments: The ES will supply and set up the Track.
   b. Virtual tournaments: Team will supply the Track that fully complies with the requirements of this section. Any deviation will be scored as a competition violation for all runs.
   c. Track Definition:
      i. The Track will be on a smooth, level, and hard surface.
      ii. The Event Supervisors must mark the track as follows:
         (1) Start Point – an approximately 5 cm × 2.5 cm tape with the Start Point marked at the center of the tape.
         (2) Target Point – an approximately 5 cm × 2.5 cm tape with the Target Point marked at the center of the tape. The Target Point is placed at the Target Distance from the Start Point.
         (3) **Imaginary Center Line is a line not placed on the Track that starts at the Start Point and extends through the Target Point.**
         (4) **Bottle Line – an approximately 2.5 cm width tape placed at the Bottle Line Distance beyond the Target Point. The Bottle Line is perpendicular and centered to the imaginary center line. The Bottle line is at least 1.0 meter wide. The edge of the line closest to the Target Point defines the line.**

(5) **Water Bottle Location will be along the imaginary center line at different distances from the Start Point based on the tournament level. For Regionals/Invitationals, the distance is 2.0 m. For States, 3.0 m. For Nationals, 4.0 m. The non-optional Water Bottle is placed centered at this location.**

iii. The Track Area will have a width of 2.0 m and extend at least 1.0 m beyond the Target Point. More space may be available but is not guaranteed.

iv. At the ES's discretion, more than one Track may be used. If so, the team may choose which Track they use but must use the same Track for both runs.



8. **DEFINITIONS:**

a. *Event Supervisor (ES)* is responsible for ensuring the event runs correctly. The ES can assign one or more event helpers to perform various competition tasks.

b. *Batteries* are commercial batteries, including rechargeables, labeled as AA batteries. Individual batteries must have a voltage between 1.2 and 1.5 volts when fully charged. The battery label must be the manufacturer's original label and easily viewable by the ES. The batteries must be individual batteries and removable from a battery pack. Batteries containing lithium or lead are prohibited.

c. *Components* can be, but not limited to, motors, gearboxes, motor controls, bodies, and chassis.

d. *Electronic components* can be, but not limited to, solid-state devices such as transistors, integrated circuits, diodes, and microprocessors. Cameras of any type or purpose are prohibited. Sensors with lasers are prohibited.

e. ***Vehicle Front* is defined as the side facing the Target Point when the Vehicle is placed in the Ready-to-Run position.**

f. *Measurement Point (MP)* must meet the following requirements:

i. The MP may be made of any material (e.g. wooden skewer, toothpick, pencil, dowel). Examples include but are not limited to: tip of a skewer/toothpick, tip of a pen, tip of a nail/paper clip/wire, corner of a wedge, the edge of a dowel.

ii. The MP must be less than or equal to 1.0 cm above the Track.

iii. The MP **must be the rearmost** part of the Vehicle. The MP must be easily accessible for measurements while the Vehicle is on the Track.

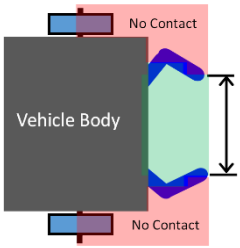
g. *Tools* may be electric and electronic tools. To qualify as a Tool, the item must not travel on the Track with the Vehicle and cannot be used to align or aim the Vehicle.

h. Target Distance is selected by the ES and will be between 5.00 and 9.00 meters. At Regionals/Invitationals the interval will be 0.25 m, for States 0.10 m, and for National 0.01 m.

i. *Target Time* is selected by the ES and will be between 10.0 and 20.0 seconds. The interval will be 0.5 seconds for all tournaments.

j. ***Bottle Line Distance* is selected by the ES and will be between 1.00 and 3.00 meters. At Regionals/ Invitationals the interval will be 0.25 m, for States 0.10 m, and for National 0.01 m.**

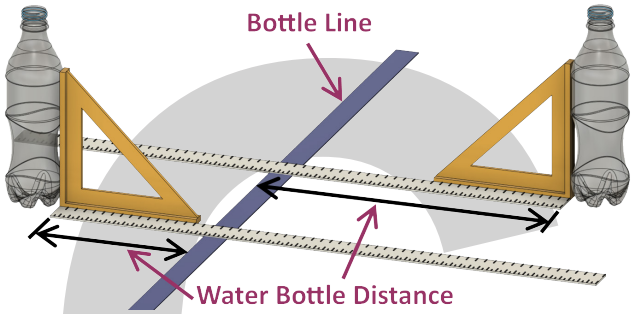
k. ***Water Bottle*** **is a single-use clear plastic 16.9 oz (500ml) water bottle with a diameter between 6 and 7 cm and a height between 18 and 22 cm. The bottle's weight will be between 80 to 100 grams. Metal (non-lead) BBs or similar will be used to increase the bottle's weight. Liquids cannot be used.**



l. ***Moving Water Bottle Requirements*** **are defined as:**
   i. **The Bottle must remain in contact with the event floor at all times. No part of the Vehicle may extend under the Bottle.**
   ii. **The Bottle must remain upright at all times.**
   iii. **The Bottle may only be pushed.**
   iv. **Only the Bottle Pusher may contact the Water Bottle. No part of the Bottle Pusher or Vehicle beyond the measured opening may contact the Water Bottle. See example.**

m. *Vehicle Distance* is a point-to-point measurement from the Vehicle Measurement Point to the Target Point, measured to the nearest 0.1 cm.

n. ***Water Bottle Distance*** **is a point-to-line measurement from the Bottle Line to the Water Bottle's closest side, measured to the nearest 0.1 cm. Use a square to find the Bottle's side. If the Bottle is resting on top of the Bottle Line, then both the front and rear side of the Bottle is measured to the Bottle Line and the smaller distance is used.**



o. *Run Time* begins when the team actuates the Vehicle and ends when the Vehicle comes to a complete stop.
   i. **Any pause between the actuating the Vehicle and the Vehicle moving will be included in the Run Time. This pause can be longer than 3 seconds.**
   ii. Recoil or oscillations will be included in the Run Time.
   iii. The Run Time is recorded in seconds to the precision of the timing device used.
   iv. Three timekeepers should be utilized with the middle time used as the official Run Time.

p. *Complete Stop* is when the Vehicle is stationary for 3 or more seconds. The 3 seconds is not part of the Run Time.

q. *Successful Run*: Any run when the Vehicle moves before the end of the Event Time and is not a Failed Run.

r. *Failed Run:* A run will be scored as a Failed Run when one of the following occurs. Construction and/or Competition Violations must still be recorded for Failed Runs.
   i. The Vehicle travels the wrong direction from the Start Point.
   ii. The Vehicle starts before the Event Supervisor is ready.
   iii. The Vehicle's distance(s) cannot be measured (e.g., the participants pick it up before it is measured).
   iv. The team pushes the Vehicle down the track.
   v. A team having only one successful run during the 8-minute Event Time will be assessed a Failed Run for a 2nd run score. If the Vehicle does not move during the Event Time, the team will be assessed 2 Failed Runs.
   vi. **Teams may request a run to be scored as a Failed Run. If this request is for the 2nd run, then the team's event time will stop.**

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