



WWFIRST 2021 Smart Robot Car Competition

The competition	2
The Game	2
The Field	3
72" x 72" Full field	3
Field Measurements	4
72" x 36" Half field	4
The Game Piece	5
Game rules	6
Global Rules (Applies to half field & full field play.)	6
G1. Penalty points score for the opponent	6
G2. Robots start inside the starting zone	6
G3. Robots stay inside the field perimeter	6
G4. Humans stay outside the field perimeter	6
G5. Maximum two cups controlled at a time	6
G6. Only one controlled cup in contact with the field at a time	7
G7. Scored cups cannot be returned to the field or moved to a higher-scoring zone.	7
G8. Autonomous scoring	7
G9. Teleop scoring	9
G10. End game scoring	13
G11. Robots must stop at the end of the game	13
Full Field rules	14
G12. Robots stay on their side during auto	14
G13. Stealing cups in auto	14
G14. The zones shift for teleop	14
G15. Robot to Robot Interaction in Teleop and Stealing Game Pieces	15
G16. No touching opponent's scored cups	15
G17. End game scoring	15
Robot rules	17
R1. Robot maximum dimensions and weight	17
R2. Robot assembly and modifications	17
R3. Allowable building materials & parts	17
R4. Allowable electronic components and controller data states	17
Tournament rules	18
T1. Bracket	18
T2. Replaying a match	18
T3. Championship Tie Breakers	18
Glossary	19



The competition

Our world changed dramatically at the beginning of 2020. As the pandemic took hold over our lives, many of our daily experiences moved into virtual environments. One aspect which FIRST Robotics aspires to, is to make science and technology fun. So within our FIRST Hub, Waterloo-Wellington FIRST Robotics Organization, we decided to create a game which could be used at home, was inexpensive to obtain, was able to provide the concepts of FRC and could be used in a fun, competitive environment.

Through the uniquely engaging combination of workshops provided by many FRC mentors, problem solving in teamwork, and many fun challenges with the Smart Robot Car, you will learn, in a hands-on environment, the many concepts and fundamentals of programming, electronics, physics and so much more in a fun and interactive way.

The ultimate goal of this competition is to create alternative, innovative and efficient ways to move objects into a specified location. This will require full control of the objects in a 3 dimensional space, including the possibility to lift one or more objects.

The aim of the challenge is to provide a fun and engaging set of tasks for which students will design and build a robot. We hope to provide something for everyone with this challenge. With that aim in mind, we may choose to change or update certain game rules as needed.

After the initial release of the competition manual, updates and revisions will be released on Mondays. We will also be providing a Q&A to try and get any questions answered in a timely manner.

The Game

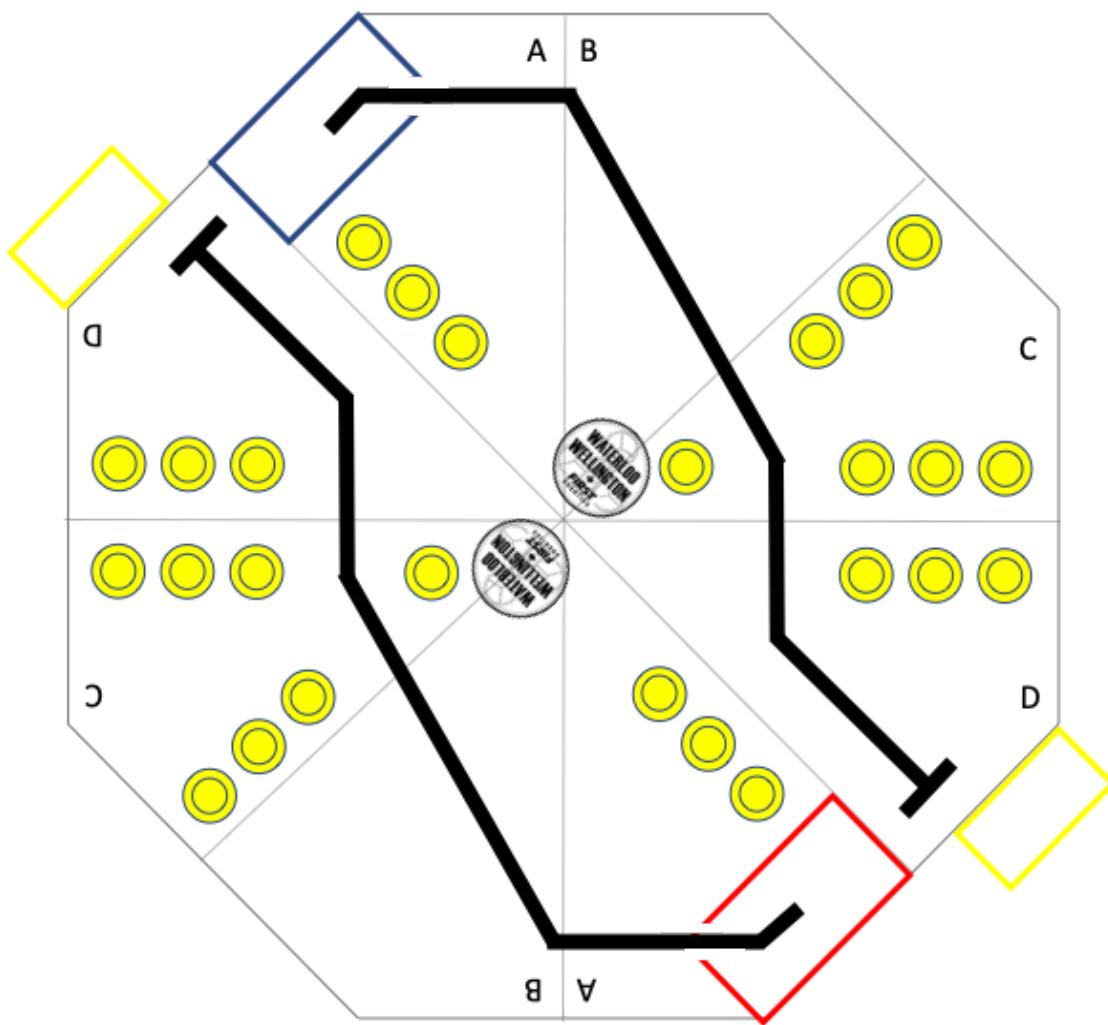
Each half of the field has 13 markings for cups to be set up in an upright orientation before the match begins. The main objective of the game is to move these cups outside of the field perimeter or into designated scoring locations. In order to count for points, the cup must be entirely outside of the field perimeter or contained within a scoring location as defined in the rules. There are also points associated with clearing the zones of cups.

Robots begin the match inside of their starting box. There is a 15 second period at the start of the match where robots may navigate autonomously, accruing points for passing into various zones. After the autonomous period, robots have 75 seconds to maneuver under driver control before the end of the match where points are calculated. Robots can also get a few extra points for ending the game above the logo.

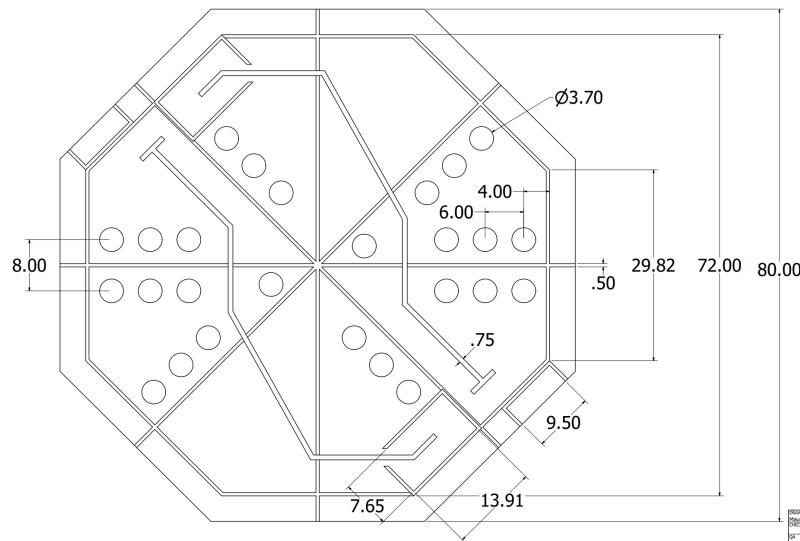
The Field

The Elegoo competition for 2021 consists of an octagon field that measures 72" x 72". The game is designed such that it can be played by a single competitor on a field that is 72" x 36".

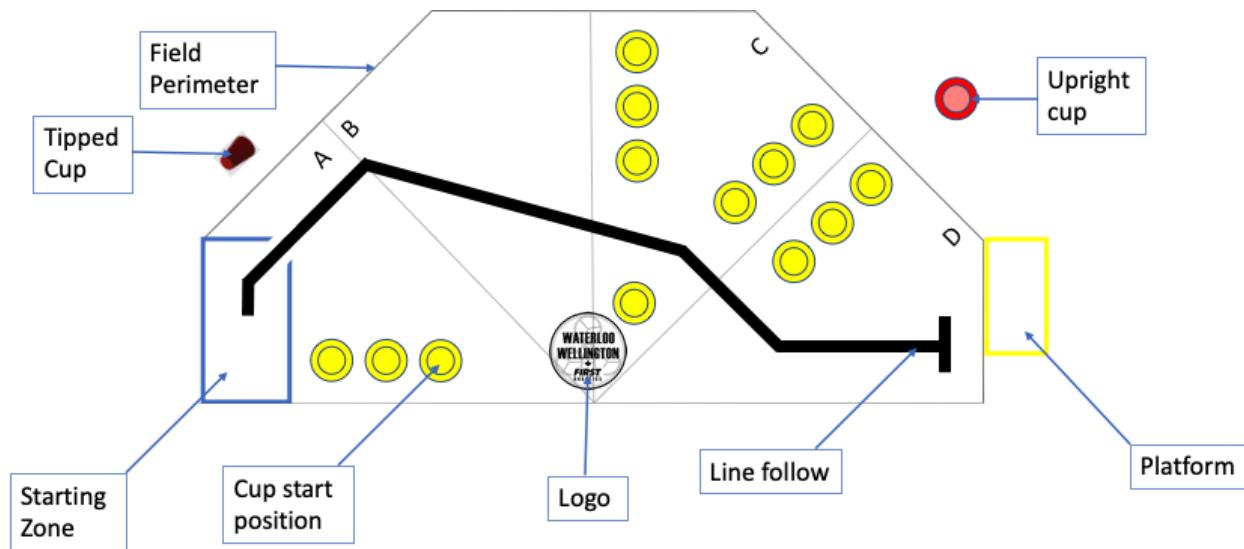
72" x 72" Full field



Field Measurements



72" x 36" Half field



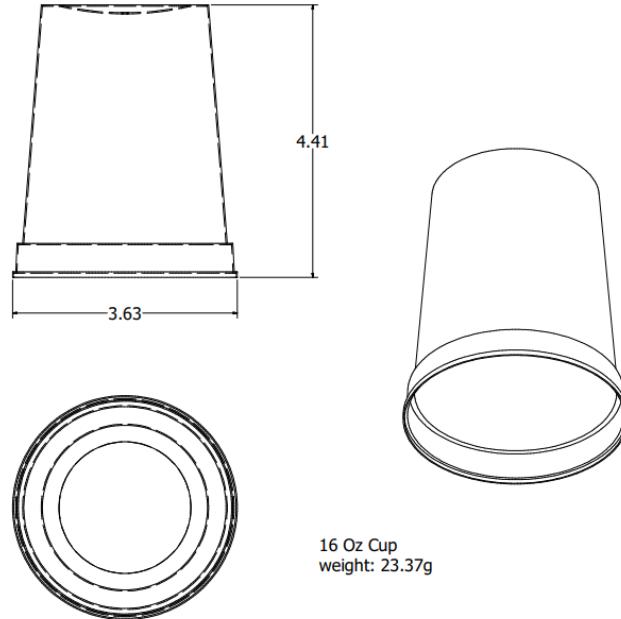
The PLATFORM consists of the cardboard Elegoo box. Once the robot is built, please tape it shut and put it on the Yellow PLATFORM Outline provided on the mat. Make sure to have the box set up with the lid upright with the closing flap away from the field and the big picture facing up.

The Game Piece

The game piece is a 16oz CUP with measurements as shown in the drawing.

13 of these will be placed upright on each $\frac{1}{2}$ field for the competition.

Game pieces cannot be modified. Violation of this rule will result in DISQUALIFICATION.





Game rules

Global Rules (Applies to half field & full field play.)

G1. Penalty points score for the opponent

PENALTY POINTS awarded for a robot's actions in a match are added to the opponents score.

G2. Robots start inside the starting zone

ROBOTS must start the match fully contained within the STARTING ZONE.

G3. Robots stay inside the field perimeter

At least 50% of the ROBOT must remain inside the FIELD PERIMETER at all times. Crossing over the FIELD PERIMETER by more than 50% will result in 1 PENALTY POINT with an additional PENALTY POINT assigned every 3 seconds until corrected.

Err on the side of caution when intersecting the FIELD PERIMETER. It should be clear to a reasonably astute observer that the ROBOT is still more than 50% within the bounds of play. ROBOTS risk being penalized for what would have been a “close call” if we could freeze time and measure!

G4. Humans stay outside the field perimeter

During a match, humans must not physically interact with the robots, either directly or transitively through another physical object. Humans must also keep all parts of themselves clear of the playing field. Violation of this rule will result in DISQUALIFICATION.

G5. Maximum two cups controlled at a time

A ROBOT may actively control as many as 2 CUPS at a time inside the field perimeter. Exceeding this limit will result in 2 PENALTY POINTS per infraction.

Control can be defined as:

1. Supporting, either partially or entirely.
2. Grabbing or Grasping
3. Imparting directional force on a CUP while contacting it, either directly or transitively through another object.

Brief, incidental contact with other CUPS on the field will not be considered control provided there is little movement. The metric we will use for determining “little movement” is displacement of the CUP by less than 50% of its diameter. Again, this is to the eyes of a reasonably astute observer.



Incidental pushing of cups that are outside the field does not violate this rule since the cups are not on the field. However, be sure not to violate rule G6.

G6. Only one controlled cup in contact with the field at a time

Only 1 CUP under a ROBOT's control may be in direct contact with the PLAYING FIELD at a time. Exceeding this limit will result in 2 PENALTY POINTS per infraction.

Therefore, to control more than one CUP at a time, one of the CUPS must be entirely supported by the ROBOT or by another CUP.

G7. Scored cups cannot be returned to the field or moved to a higher-scoring zone.

Once a CUP has left the FIELD PERIMETER and is no longer being controlled by a ROBOT, a ROBOT may not return the CUP into play or move CUPS into higher scoring zones. Violation of this rule will result in 5 PENALTY POINTS.

Moving a cup from outside the field back onto the field is a violation of G7. Shifting cups from outside the field from zone B or C into zone A or D is a violation of G7.

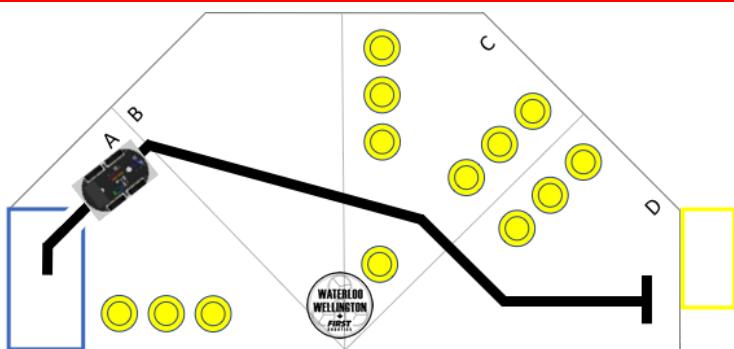
G8. Autonomous scoring

AUTO points will be awarded at the end of the 15 second AUTO period for every one of the following scenarios considered to be true when the period ends.

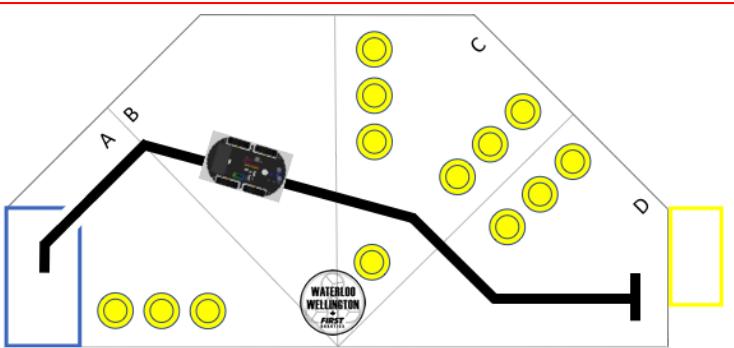
<u>Scenario</u>	<u>Points awarded</u>
A1. The ROBOT is located inside the FIELD PERIMETER and is not entirely contained within the STARTING ZONE.	2
A2. The ROBOT is located inside the FIELD PERIMETER and is not overlapping ZONE A.	2
A3. The ROBOT is located inside the FIELD PERIMETER and is not overlapping ZONES A or B.	2
A4. The ROBOT is located exclusively inside ZONE D	3

CUPS scored during the AUTO period will receive an extra 2 points per CUP on top of the regular scoring points. These points will be assigned to the AUTO period of the match.

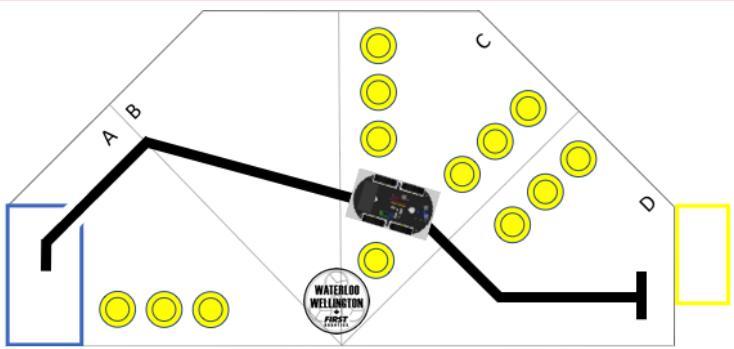
Autonomous Robot Position A1. TOTAL POINTS = 2



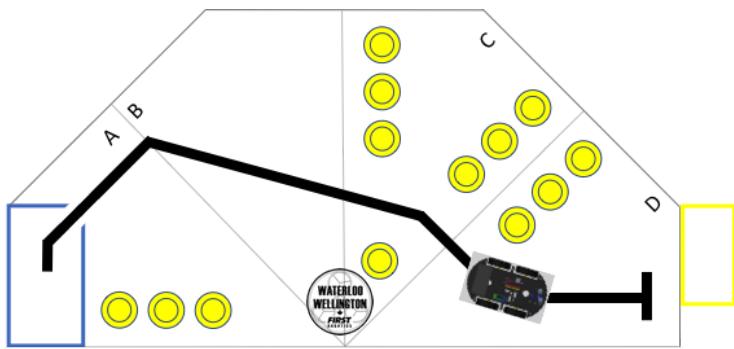
Autonomous Robot Position A2. TOTAL POINTS = 4



Autonomous Robot Position A3. TOTAL POINTS = 6



Autonomous Robot Position A4. TOTAL POINTS = 9





G9. Teleop scoring

TELEOP points will officially be awarded at the end of the 75 seconds TELEOP period for each CUP based on its location and orientation per the following table.

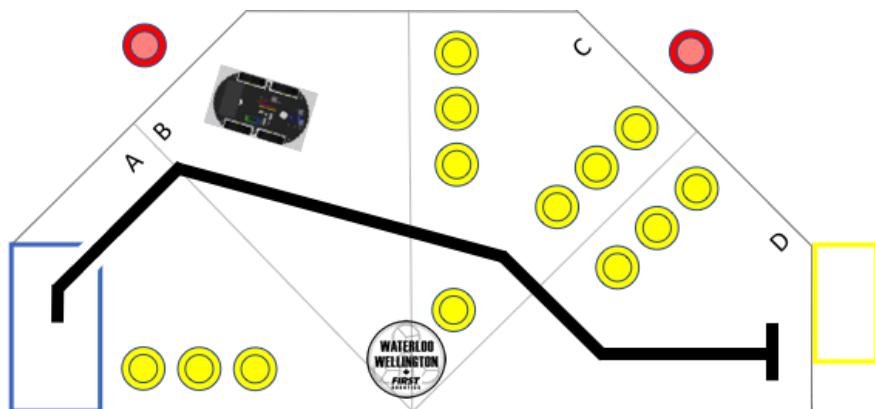
<u>CUP state</u>	<u>Points for a CUP in an upright orientation (U)</u>	<u>Points for a CUP on it's side (S)</u>
T1. Located completely outside the FIELD PERIMETER, located beyond the C or B ZONES and not controlled by the ROBOT.	2 (T1-U)	1 (T1-S)
T2. Located completely outside the FIELD PERIMETER, located beyond the A or D ZONES, not entirely supported by the PLATFORM and not controlled by the ROBOT.	4 (T2-U)	2 (T2-S)
T3. Located entirely within the STARTING ZONE and not controlled by the ROBOT.	4 (T3-U)	2 (T3-S)
T4. Located entirely within the STARTING ZONE, not in direct contact with the PLAYING FIELD and not controlled by the ROBOT. <i>For this state, you effectively need to stack the CUP on another cup.</i>	6 (T4-U)	3 (T4-S) <i>An entire stack of CUPS on it's side will have every cup in the stack considered to be in contact with the PLAYING FIELD.</i>
T5. Supported entirely by the PLATFORM either directly or transitively through another CUP and not controlled by the ROBOT.	8 (T5-U)	4 (T5-S)

Note that a CUP on it's side is worth less than if it was kept upright!

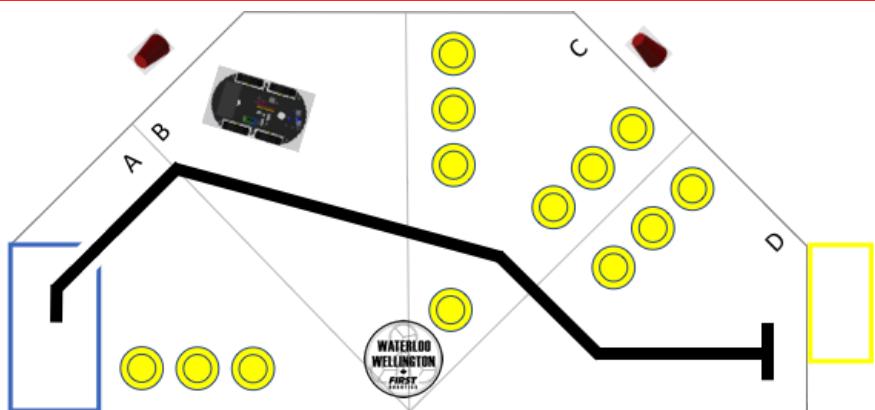
Upright orientation of a CUP means either open side down or up. Both are acceptable.

To determine which ZONE a CUP is located beyond, extend the ZONE borders outwards. (*Pictured below*) If a CUP intersects a border between two ZONES, it will be awarded the lesser point value of the two zones. CUPS intersecting the middle of the full field will have no points awarded.

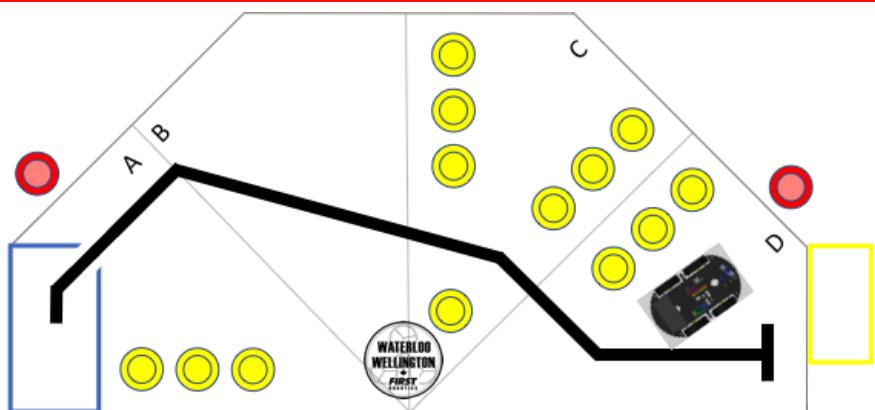
Teleop Scoring T1-U.



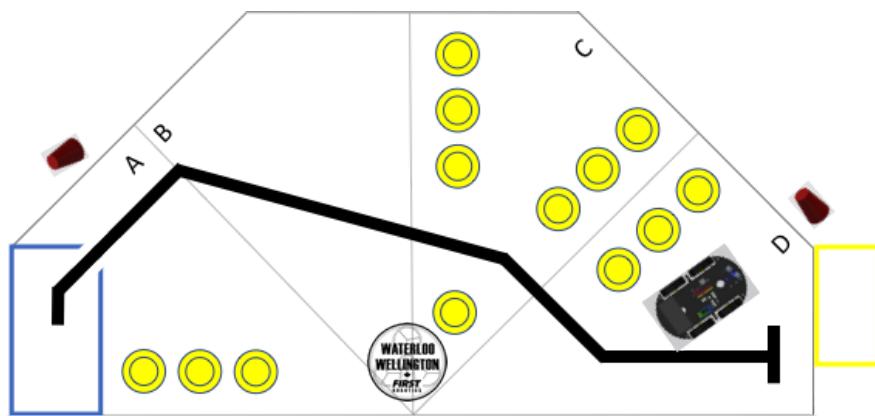
Teleop Scoring T1-S.



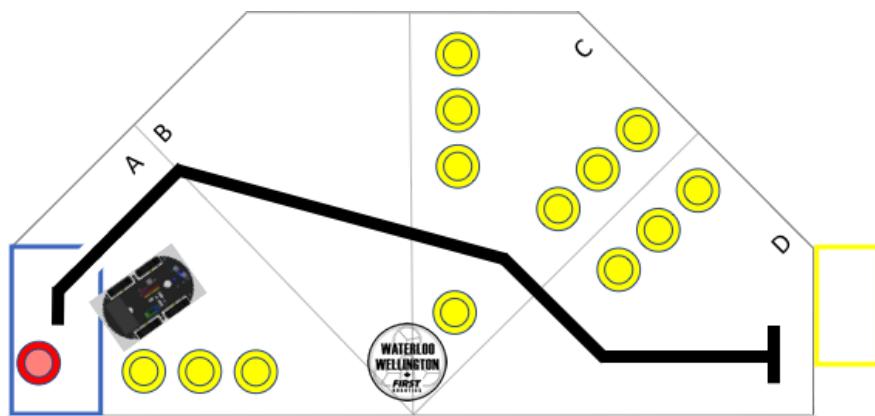
Teleop Scoring T2-U.



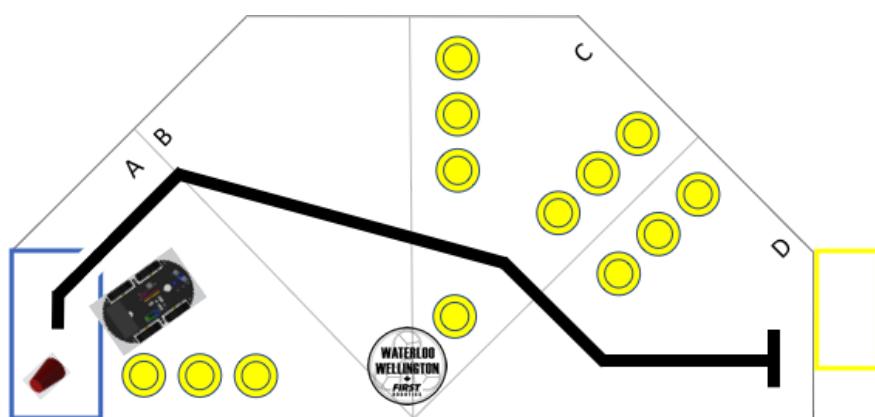
Teleop Scoring T2-S.



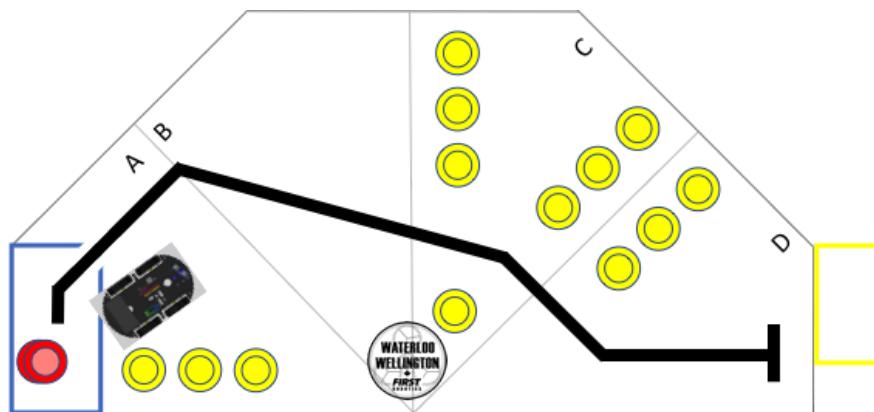
Teleop Scoring T3-U.



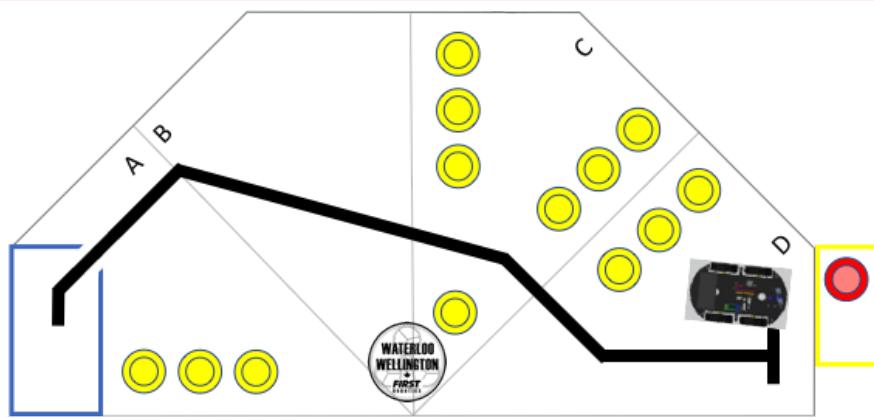
Teleop Scoring T3-S.



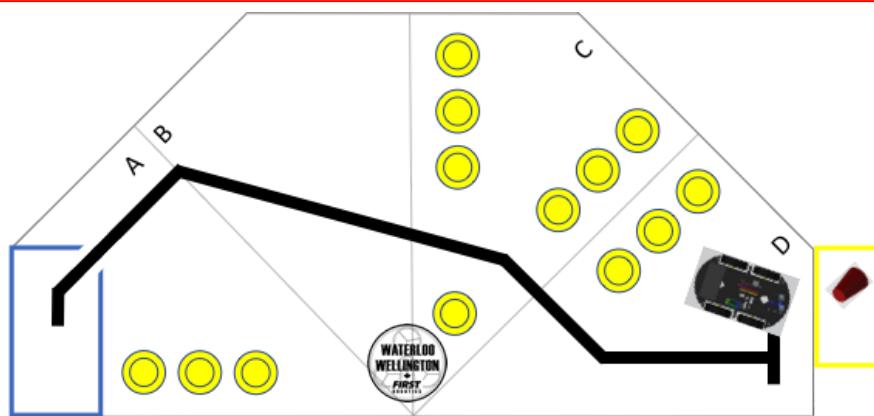
Teleop Scoring T5-U.



Teleop Scoring T6.U.



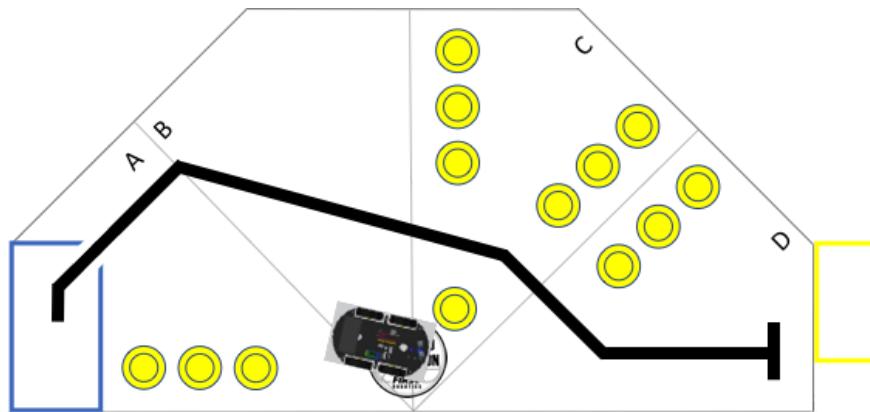
Teleop Scoring T6-S.



You'll notice that in half field play, there is an entire area beyond the line that would normally be the middle of the full field. This area has no point values associated with it so it would be unwise to put any CUPS out there. And per rule G6, if a CUP were to find itself out there, it can no longer be retrieved.

G10. End game scoring

A ROBOT will be awarded 4 END GAME points for finishing the game above the WWFIRST LOGO on it's side of the field. To be considered above the LOGO, the ROBOT must have at least one of its wheels inside the LOGO's border.



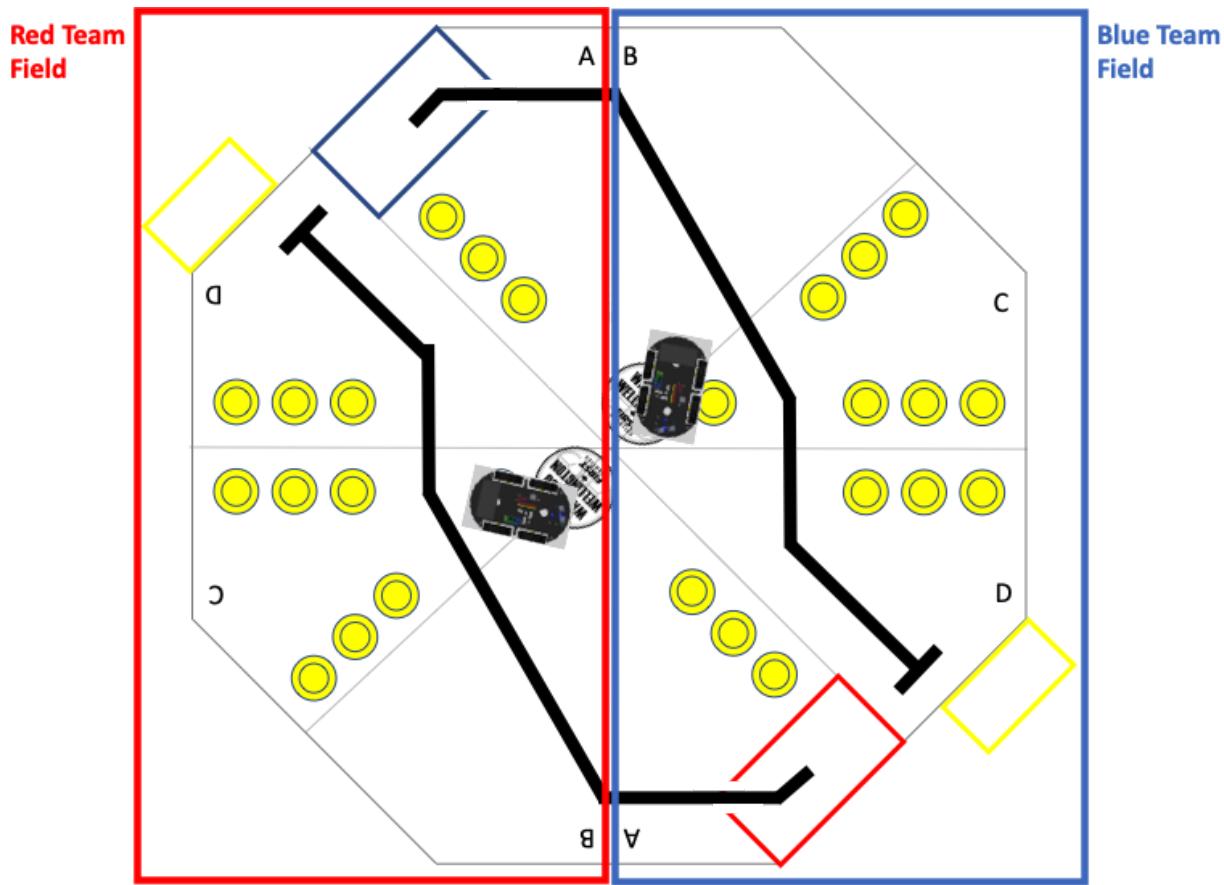
After the game ends, the following END GAME points will be awarded for each zone cleared of ALL CUPS.

Cleared Zone	Extra points awarded
Zone A (excluding STARTING ZONE)	2
Zone B	1
Zone C	6
Zone D	4

G11. Robots must stop at the end of the game

At the end of the game all activity must be stopped. ROBOTS have to stop moving within 2 seconds. Violation of this rule will result in 10 PENALTY POINTS. An additional 2 PENALTY POINTS will be assigned for every 3 seconds that this is not corrected.

Full Field rules



G12. Robots stay on their side during auto

In full field play, ROBOTS must remain on their side of the field during the AUTO period of the match. Violating this rule will result in 10 PENALTY POINTS. A ROBOT's side of the field for the AUTO period is the same as it is in half field play.

G13. Stealing cups in auto

In full field play, a maximum of 2 CUPS can be removed from the A ZONE in which a ROBOT starts the match. Violating this rule will result in 10 PENALTY POINTS.

G14. The zones shift for teleop

In full field play, the ZONE ownership shifts by one ZONE clockwise once the game enters the TELEOP period of the match. This is to say that a ROBOT's side of the field is now considered to be, following a clockwise direction, consisting of ZONE B, C, D and A.(Pictured above.)



There is a grace period of 5 seconds at the start of TELEOP for ROBOTS to leave the A ZONE in which they started the match. During these 5 seconds, PENALTY POINTS for contact(G13) won't be awarded. ROBOTS are expected to respect each other and allow ROBOTS to exit the A ZONES onto their respective sides of the field. A ROBOT preventing another from crossing over will result in 10 PENALTY POINTS or DISQUALIFICATION if egregious.

Rule G13 will continue to apply until a robot has fully moved into its side of the field during the TELEOP period. This is to say that a ROBOT may not exploit the grace period rule to steal additional CUPS beyond what is defined in G13.

G15. Robot to Robot Interaction in Teleop and Stealing Game Pieces

In full field play, ROBOTS are not to contact the opposing ROBOT on the opposing side of the field. Entering the opponent's side of the field is allowed during TELEOP only after fully exiting the A ZONE where they started onto their side of the field. If the 2 ROBOTS come into contact with each other, 5 PENALTY POINTS are awarded to the ROBOT that is fully within its side of the field. If 2 ROBOTS contact a game piece at the same time and only one of the ROBOTS is fully within its own side of the field, that ROBOT is awarded 5 PENALTY POINTS.

G16. No touching opponent's scored cups

ROBOTS may not directly or indirectly touch CUPS in the STARTING ZONE or on the PLATFORM on the opposing side of the field. Touching a cup in these areas on the opposing side is worth 10 PENALTY POINTS for a single CUP or 20 PENALTY POINTS for a stacked, upright CUP.

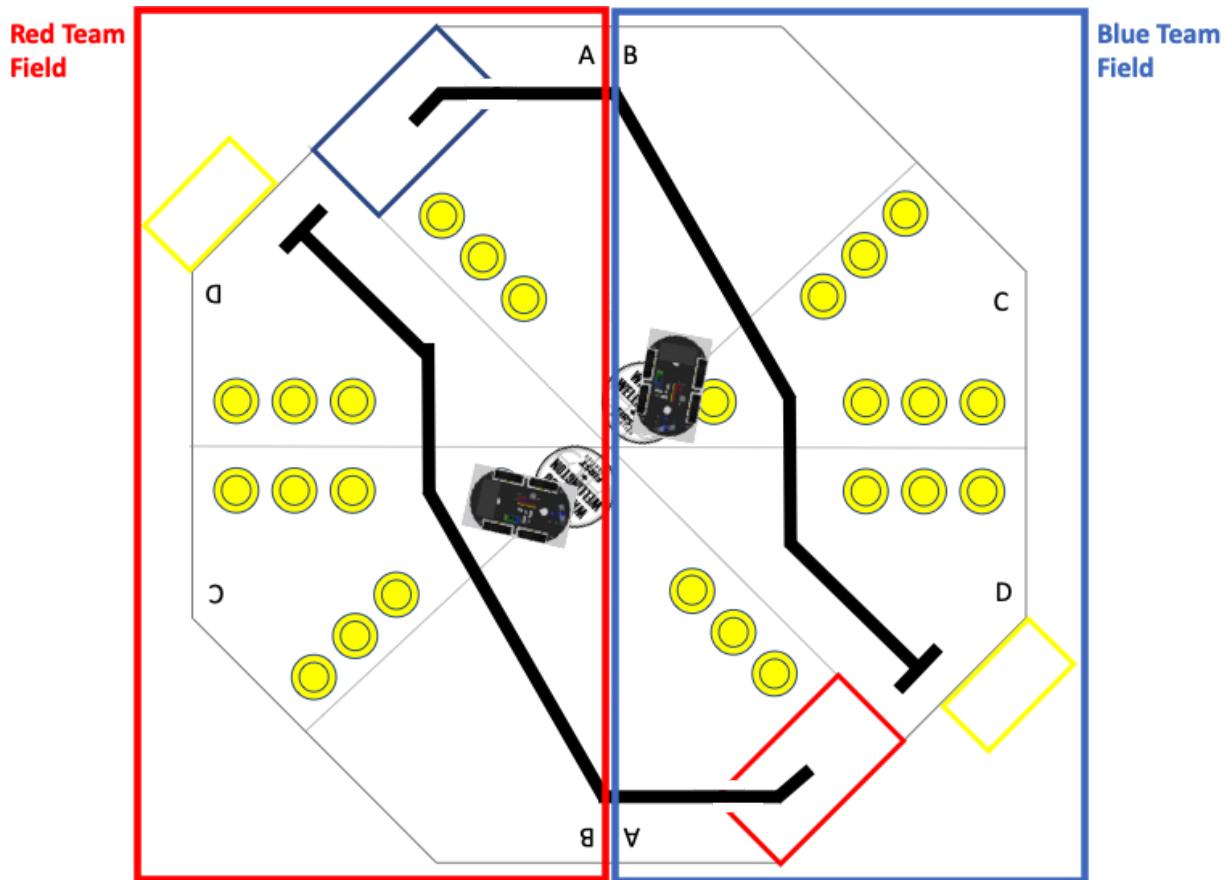
As an example of this rules applicability, launching a CUP into an opponent's scored CUP counts as indirectly touching the CUP.

Note that in full field play, the STARTING ZONE in which a ROBOT starts the match is not the same STARTING ZONE they should attempt to score in due to the ZONE shift in TELEOP. This is in contrast to half field play where a robot would be attempting to score in the STARTING ZONE where it began the match.

G17. End game scoring

A ROBOT will be awarded 4 points for ending the game above the WWFIRST LOGO on it's side of the field. To be considered above the LOGO, the ROBOT must have at least one of its wheels inside the LOGO's border and CANNOT touch any part of the opponent's field.

This rule overrides G10 by adding the additional clause of "Cannot touch any part of the opponent's field".





Robot rules

R1. Robot maximum dimensions and weight

The robot must fit inside the outside edges of the starting box on the field when the match begins, which is 7.65" x 13.91" (19.43cm x 35.33cm). The robot must not exceed a size of 10" x 16" (25.40cm x 40.64cm) at any time. The maximum height of the robot during the starting position has to be within 10" (25.40cm). The robot cannot weigh more than 6lb (2.72kg) including all extra parts and attachments.

R2. Robot assembly and modifications

The robot has to be assembled according to the documentation. There is one MANDATORY modification: each robot has to REMOVE the Bluetooth module and ADD the ESP-01 wireless module with approved Firmware, supplied in the Kit of Parts. This module will interact with the Approved Driver Station. More details, as well as information on the required Arduino DriverStation Class are available in the **Tournament Manual**.

Other modifications are allowed by removing parts of the initial configuration and/or adding extra parts provided in the **Kit of Parts**. These modifications have to comply with all the game and robot rules, including but not limited to the maximum dimensions and weight (R1). Drilling of holes or any other modifications of initial **Kit of Parts** components is NOT allowed. Violation of R2 will result in DISQUALIFICATION.

R3. Allowable building materials & parts

Attachments may be constructed from any safe materials and parts you choose. These include but are not limited to cardboard, wood, Lego, 3D printed parts, etc. The attachments have to comply with all the game and robot rules, including but not limited to the maximum dimensions and weight (R1).

R4. Allowable electronic components and controller data states

Only electronic parts provided in the **Kit of Parts** can be used to extend or modify the robot. You are allowed to set electronic components to known positions pre-match. The driver station will set all controller data to neutral/unpressed states during pre-game, autonomous, and postgame.



Tournament rules

T1. Bracket

The **WWFIRST 2021 Smart Robot Car Competition tournament** will be played over multiple virtual events held at different predetermined dates and times. Each participant will be randomly placed in a tournament with a maximum of 32 participants per tournament.

Each participant will play 2 voluntary practice matches and 3 mandatory qualification matches, each played in a round robin bracket.

Each tournament will advance a preset number of participants, determined by a maximum total of 32 advancing participants to the Championship. The Championship will be played in a single elimination bracket.

T2. Replaying a match

The tournament runners reserve the right to have a match replayed. This is in case of unforeseen situations we could not predict which potentially jeopardize the sanctity of a match. It will be up to the discretion of those running the tournament as to whether a match will be replayed. Tournament runners are advised to get input from those immediately affected before making a final decision. In the event that a match is replayed, its outcome will overwrite the results for the match it's replacing.

T3. Championship Tie Breakers

In the event of a tie, a winner will be determined in the following order.

1. Greater number of AUTO points.
2. Greater number of PENALTY points.
3. Greater number of PLATFORM points.
4. Greater number of END GAME points.

If after all that the game remains tied, we will replay the match.

Glossary

TERM	DEFINITION
ZONE (A, B, C, D)	Each half field has 4 zones, indicated by A, B, C and D.
STARTING ZONE	Each half field has a starting zone, outlined by a blue or red rectangular box located inside the A zones.
PLATFORM	Each half field has one platform, outlined by a yellow rectangular box located outside the D zone. The Elegoo box is placed here to create a raised scoring platform.
CUP	The game piece with which the game is played. There are 13 cups placed on each half of the field.
LOGO	The Waterloo Wellington FIRST logo. Located across the B and C zone on each half of the field and used as an objective during the end game.
FIELD PERIMETER	Outlined in grey and in the shape of an octagon. This delimits the play area. (Half octagon in half field play.)
TELEOP	A 75 second period of the match where operators control their robots directly. It follows the AUTO period.
AUTO	A 15 seconds period of the match where robots run autonomously. Matches begin with this period.
END GAME	A virtual period of the match for which certain actions have their points assigned. These are actions which are only considered completed after the match has ended.
PENALTY POINT	Points awarded to the opponent due to voluntary or involuntary actions which violates the game rules.
ROBOT	Elegoo Smart Robot Car V3.0 and allowed extra components provided in the Kit of Parts, as well as any attachments within the limit of the robot rules.
DISQUALIFICATION	If a robot is considered disqualified from a match. The match is counted as a loss for that robot, regardless of the initial score outcome.

