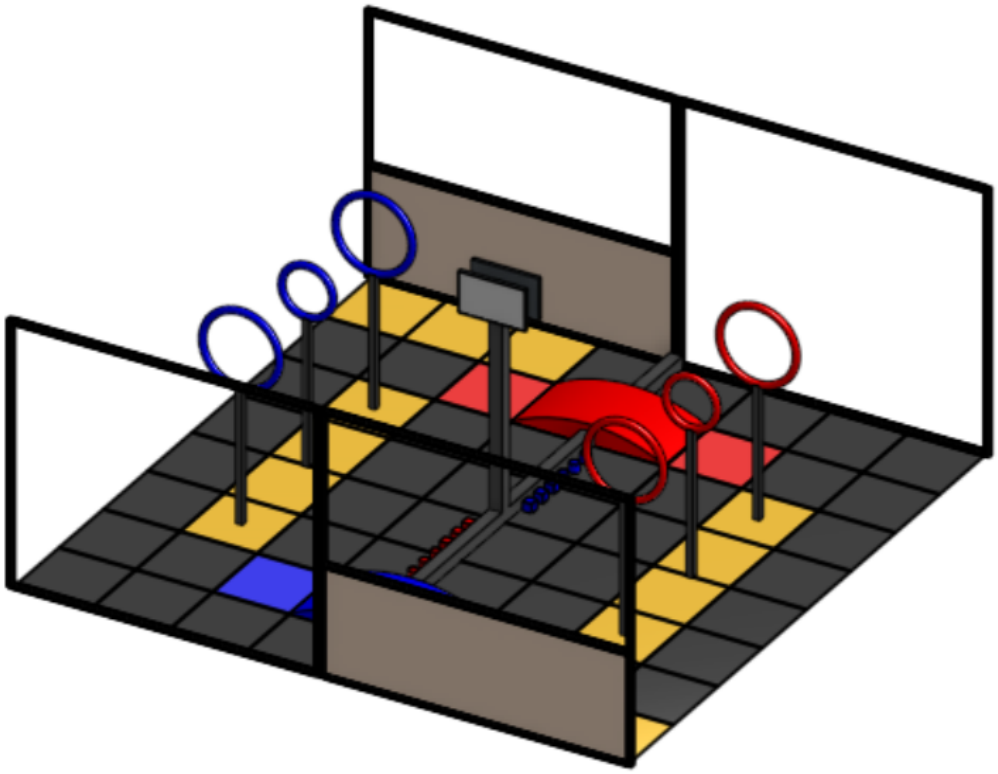
ROBOT DRONE LEAGUE

Junior!

THREE RING CIRCUS



2024 Official Challenge Rules and Guide

Three Laws of Robotics

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.

2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.

3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

~Isaac Asimov

And one more….

4. A robot may not intentionally injure another robot unless the action or inaction conflicts with the First, Second or Third Laws. ~ Scooter Willis (Creator of RDL)

To the teachers who passionately lead the entire future of our world from their classroom….~ Thank You ~

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Revisions Date	Page	Notes
12/1/2023	**All**	**Challenge manual revised, new RDL Jr. Challenge Field drawings**

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Introduction

Creativity and innovation are key elements to advancing the fields of science, technology, engineering and mathematics (STEM) into the future. Robot Drone League (RDL Jr) Junior has been designed to provide younger students with open-ended challenges that allow for creation and innovation by engaging in hands-on design, engineering, and programming of interactive robots and drones. Students are presented with the opportunity to develop real-world connections to classroom learning. Working with robots in a collaborative game format can be a very powerful tool to engage students and enhance math and science skills through hands-on, student-centered learning. Through participation in RDL Jr., students develop the essential, early-on, life skills of teamwork and collaboration, as well as critical thinking, project management, and communication required to become the next generation of innovators and problem-solvers in our global society. The 2023 RDL Jr. “Three Ring Circus Challenge", presented by STREAMWORKS, is designed to inspire younger students to develop a lifelong passion for learning and pursue educational and career opportunities in STEM fields by implementing real-world STEM-related problems that require innovative and critical thinking to find solutions.

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Please visit www.robotdroneleague.com

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Challenge Overview

RDL Jr. 2023 Challenge: Three Ring Circus

The “Three Ring Circus” Challenge includes an exciting Robot Drone League Jr. game, centered around real-world aspects of machine control and gaming strategy. Team work, communication, and practice are key to scoring maximum points.

At the designated drive station, teams consisting of 2 – 4 students are assigned the mission of retrieving game elements, previously referred to as *pucks* and *cubes,* from the opponent’s side of the RDL challenge field. While retrieving the game elements, teams are challenged to demonstrate control and function of both the robot and the drone by performing maneuvers over uneven terrain, line following, stopping / starting on designated zones, activating beacons, and performing aerial stunts.

The RDL Jr. “Three Ring Circus” Challenge provides an opportunity for students, with the unassisted guidance of mentors, to build and program a robot and drone to execute accurate movements and accomplish assigned field challenges. Students collaborate in a teamwork format to strategically collect scoring elements and solve math and science questions for competitive points.

RDL Jr. emphasizes the importance of programming through drone technology. In this year’s challenge, teams are encouraged to utilize the drones image sensor to solve STEM questions when displayed on the field monitors.

RDL Jr. implements Next Generation Science Standards (NGSS) through the completion of grade-appropriate science and math questions.

Game Rules

Object of the Game

The object of the game is to successfully complete as many of tasks as possible within a five-minute match, with the first sixty seconds considered autonomous conditions. RDL Jr. “Three Ring Circus” is played on a 492.76 cm (194.00 in.) by 487.68 cm (192.00 in.) indoor and enclosed field, surrounded and separated into equal halves by a combination of game elements designed for the current RDL Jr. challenge, “Three Ring Circus”. Two teams compete against each other as either the red or blue alliances. The two alliance field sides are mirror images of each other. There are 3 gaming pucks and 3 cubes per alliance that teams may retrieve and transport to the yellow scoring zone. The object of the game is to retrieve the gaming pucks located in an assigned area located on the opponent’s side of the playing field.

Teams must utilize the terrestrial robot to traverse over the uneven terrain bridge (of the assigned alliance color) in order to gain access to the opponent’s field. Solid white lines, one-half inch in width, are located in a linear pattern on the field surface and are designed to aid teams attempting autonomous movement of the robot. Remember, the first 60 seconds is specifically set aside for autonomous movement of both the robot and the drone.

Drones are tasked with performing a successful take-off and navigating through an array of aerial challenges, to include target takeoffs and landings, safely passing through aerial hoops, and performing any combination of aerial stunts and target collection within the 5 minute time limit or until one or both sides accomplish maximum points. Aerial stunts are classified as specific and intentional aerial maneuvers, i.e. flips, rotations, rolls, etc. Please see both autonomous and teleop scoring charts for possible points. The drone is also a resource for providing images of the screen on the opposing side, which displays STEM questions for teams to attempt to correctly answer.

Matches

Teams will compete in between two or more scoring matches in which teams are randomly assigned to an alliance drive station and will compete for the highest score on the field. The first minute requires robots and drones to operate autonomously. This is followed by a four-minute teleop period of robots and drones operated under the control of the humans. Practice matches will be allowed if time permits.

Yellow Start / Stop Area

For each alliance side, there is a designated area for start and finish of the robot and drone and is adjacent to the assigned drivers station. Three yellow colored field mats are 60.96 cm / 24 in. each and will be utilized for all starts, stops, and resets for drone and robot during the 5-minute match period. All scoring elements must be successfully delivered back to the yellow mats which is also considered the scoring zone. The RDL Jr. field official is the only human allowed on the field at any time and within the Yellow Start / Stop Area.

Three Rings

The RDL Jr. field has three rings located in the center of the field. The Outer RDL logo rings measure 48.00 in. / 121.92 cm in diameter and the center Blue or Red ring measures 24.00 in. / 60.96 cm. Teams are awarded points with each successful passing of each ring, regardless of number of attempts. With exception of autonomous mode, drones must first pass through the larger ring located at the furthest distance from the drivers' station and then travel through the smaller center ring, and then exit the stunt zone through the larger colored ring. For example, the Red Alliance driver station drone must pass through the RDL Jr. ring furthest from the corresponding driver station first when attempting a ring fly through and /or aerial stunts within the stunt zone, and then pass through the corresponding-colored ring, Red or Blue, at midpoint, and then complete the ring course by passing through the RDL Jr. ring last in one continuous and interrupted flight. Teams are not permitted to repeatedly pass through one single ring on any given attempt unless the drone has been reset in the yellow start / stop zone. Teams attempting to perform aerial stunts with the drone must pass through all three rings successfully during a single attempt in order to receive any attempted aerial stunt scoring points. In the event of a drone crash, the RDL Jr. field official will perform an immediate "drone rescue" and reposition the drone at the teams assigned yellow mat start / stop area for any subsequent relaunch.

Starting Position

Robots and drones are to be placed in the starting position prior to beginning the match. The starting position is marked by three adjacent 61.0 x 61.0 cm / 24.0 x 24.0-inch yellow squares, positioned directly in front of the assigned driver's station. Robots and drones may start from any orientation or positions with adaptive elements (Velcro, colored tabs, etc.) while in the yellow start / stop areas. Alignment tools and devices are allowed onto the playing field as long as the tools do not interfere with the ability of the opposing alliance to retrieve game elements and score points.

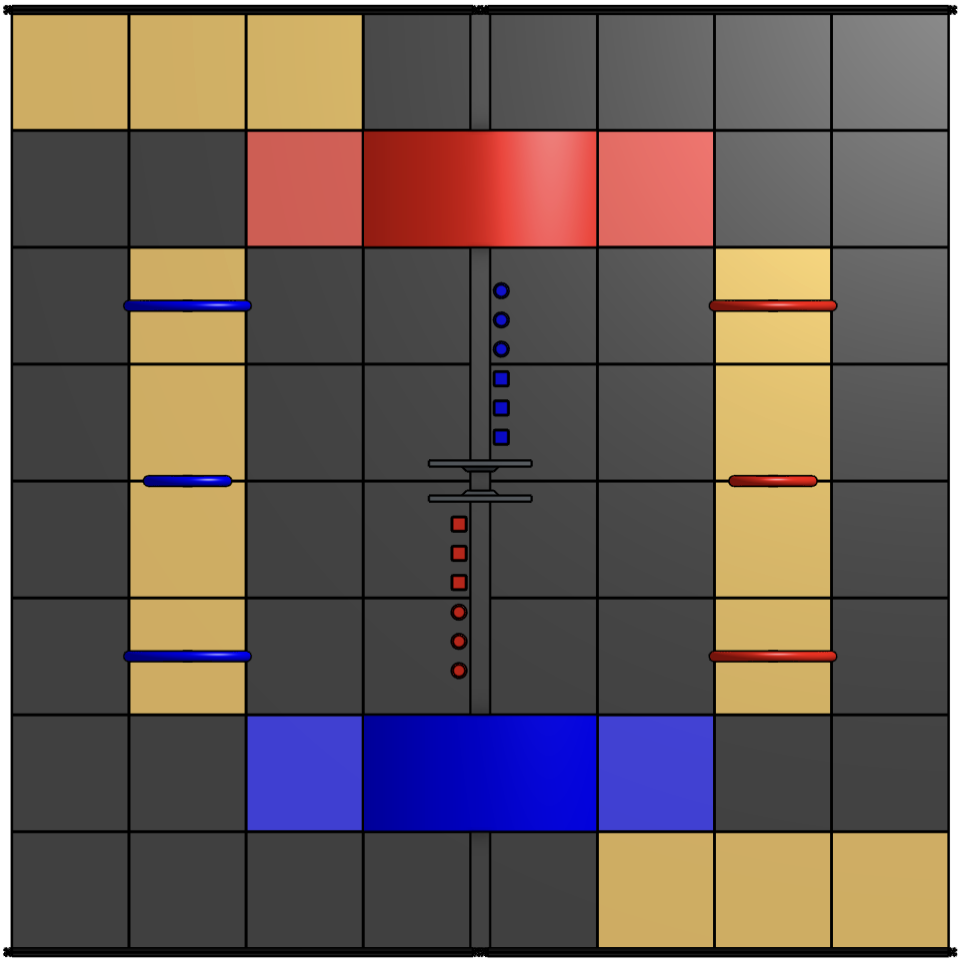

Figure 1: RDL Jr. Field, Birds Eye

Figure 2: Start / Finish

STEM Questions

Each team is given the opportunity to earn points by solving one (1) STEM-based question that appears after the match has started. During a 3-minute match, there are a maximum of four (4) additional questions to be gained by each alliance. Teams are encouraged to attempt all questions by positioning the drone in front of the opposing sides display and capturing the image utilizing the drone camera. Questions are displayed on screens on the opposing side of the field, precisely 180 degrees from the drivers station. Teams must use the drone camera feed to view the questions in order to solve them. Teams will receive a maximum of five (5) STEM questions per scoring match.

STEM questions are aligned with NGSS, Common Core, ISTE, and P21 Standards and are directly correlated to what students learn in the classroom.

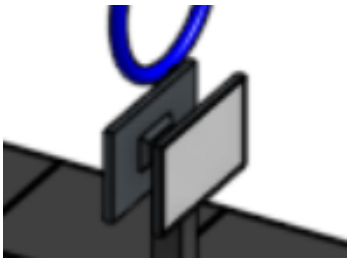

Figure 3: STEM Displays

Power Elements

On the field, there are three (3) power pucks located adjacent to the center wall barrier, nearest the rough terrain bridge. Each power puck has Velcro tabs affixed (loops) to the sides to aid teams with element collection. RDL Jr. will provide additional Velcro (hooks) at competition. Teams must first attempt to retrieve the power pucks of the assigned

alliance color during the first two minutes of each match. For example, the Red Alliance team must initially attempt to retrieve the red power pucks from the opposing side field. After two minutes have expired in a 3-minute match, teams are allowed to retrieve any colored power puck that remains on any part of the field of play, except in the yellow zones. Power pucks retrieved and placed in the START / FINISH HERE (yellow zone) area of each alliance are considered scored points and no longer in play.

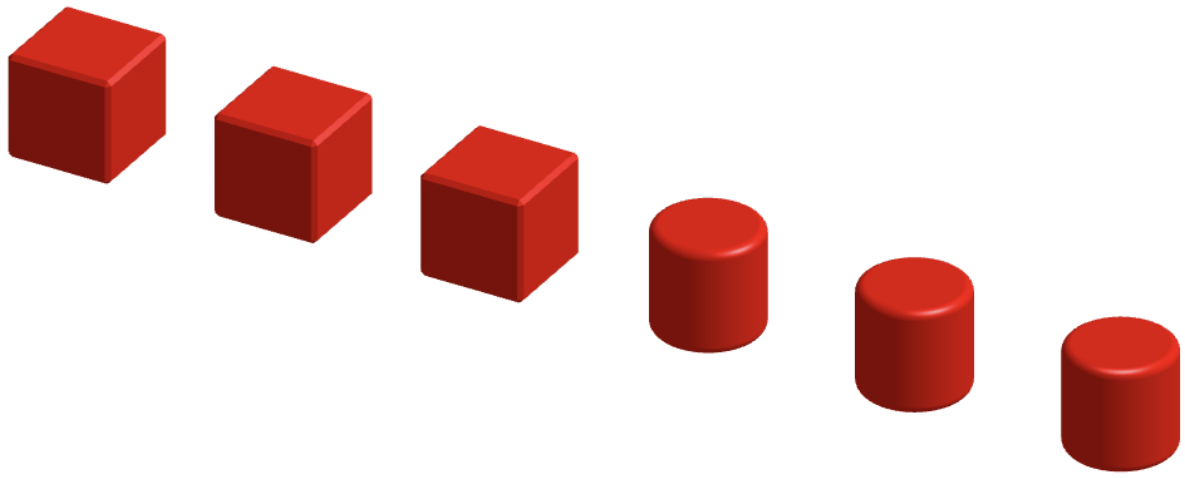

Figure 4: Power Elements

Rough Terrain Bridge

Two bridges connect the red and blue alliance sides of the field. Robots are permitted to traverse the bridges during all phases of each match. The bridges are identical in terms of terrain and difficulty. If a robot falls from the bridge and is unable to regain functionality, the RDL Jr. field official will recover the robot and reset it in the START / FINISH area. Teams are allowed to reattempt traversing the bridge an unlimited number of times during the 5-minute match.

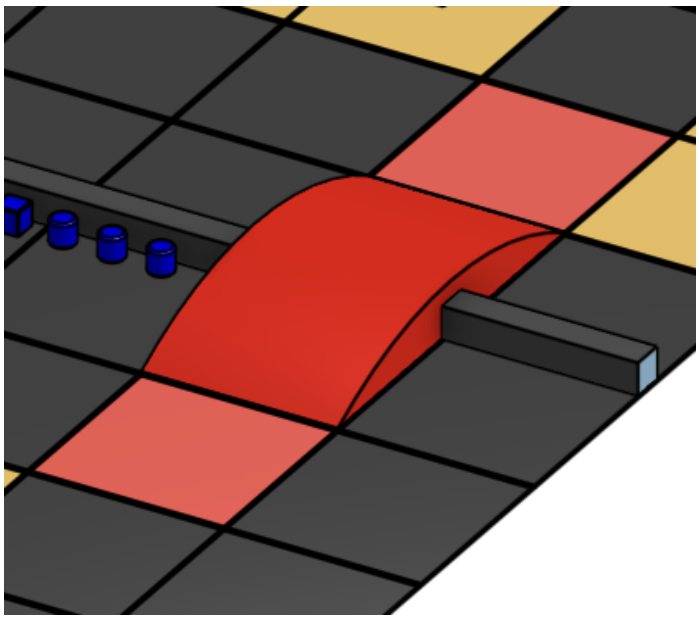

Figure 5: Rough Terrain Bridge

Beacon

On the field, there are two (2) beacons, one on each side of the field, that are activated by a close proximity drone fly over in which a color coded tile will activate the beacon to the assigned alliance color. This is referred to as a “beacon capture”. Upon capture, the beacon will illuminate with the corresponding assigned alliance color, either Red or Blue. During the final one minute of match play, an opposing drone is allowed to fly into the opposing player's air space and attempt a beacon capture. Drones are allowed to recapture beacons during regular match play for an unlimited number of attempts, until time expires. Drones may not make contact with any other drone or robot during any flight operations. Intentional contact will result in penalties and point reductions from the final match score. Please note there are a few regionals that do not have beacon equipment and will often utilize red or blue balloons, each scoring event recorded upon drone contact.

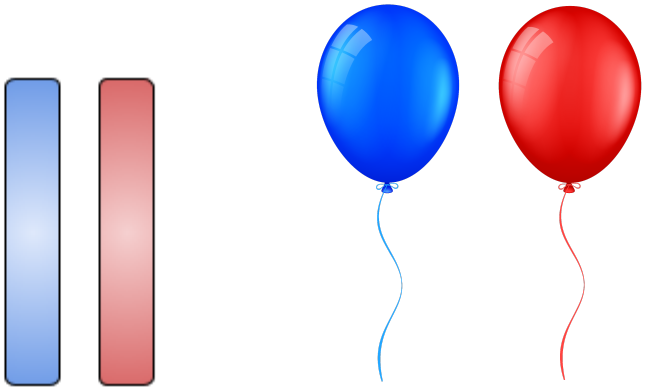

Figure 6: Beacon

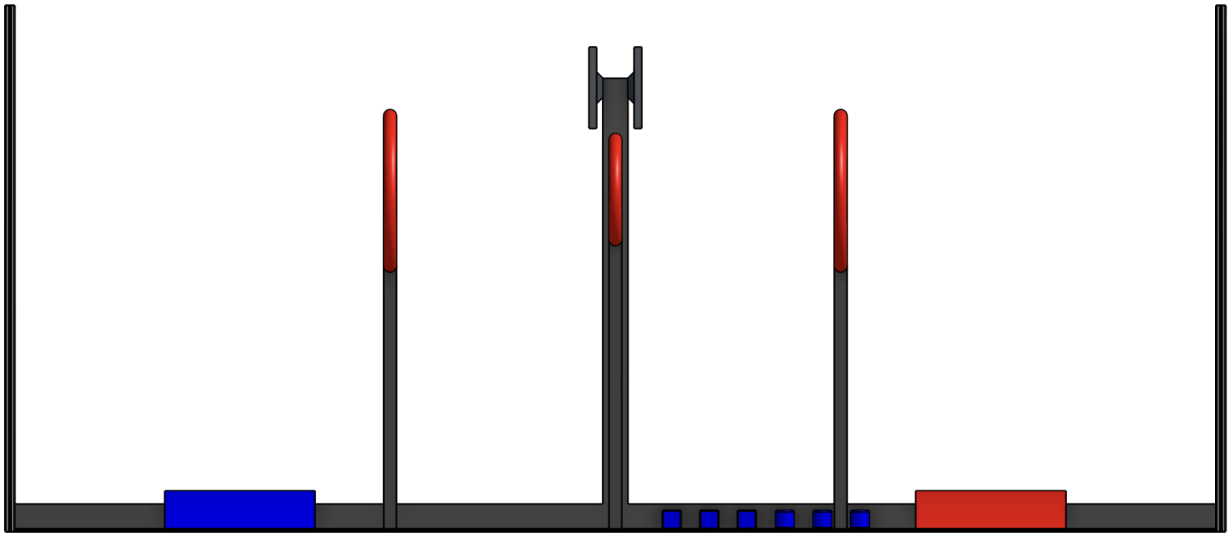

Figure 7: Field Side View

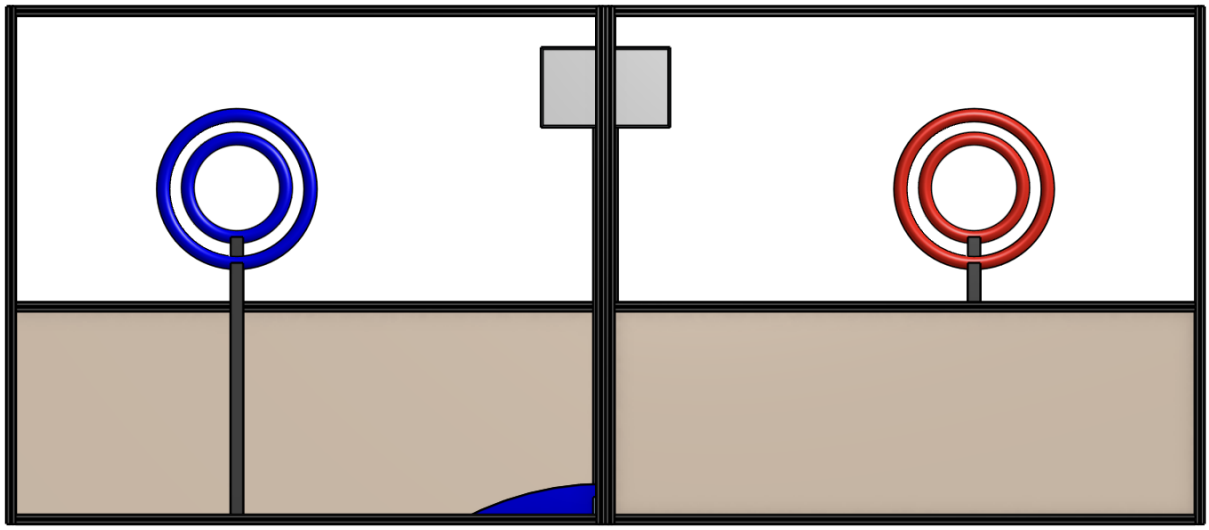

Figure 8: Field Front View

Autonomous Period

At the beginning of a 5-minute match, the first 60 seconds is considered the autonomous period. Human control of the robot or drone is not allowed. Teams are awarded points for autonomous movement of the robot or drone as depicted in the scoring table below. Drones and robots may score autonomous points independent of each other. Completing tasks autonomously (during the autonomous period) results in maximum points. During the autonomous period, teams are not allowed to modify their code or run their programs multiple times. Programs initiated must be done in one press of the “start button.”

Autonomous – 01:00 minute	***Action***	***Element***	***Robot/Drone/ Lab***	***Points Each***
	Movement beyond the starting block area	*Field*	*Robot*	***100***
	Movement beyond the starting block area	*Field*	*Drone*	***100***
	Line Following	*Field*	*Robot*	***100***
	STEM question	*#1 STEM Question*	*Human*	***250***
	Beacon activation	*Beacon*	*Drone*	***200***
	Traverse and cross uneven terrain	*Bridge*	*Robot*	***40***
	Collect pucks	*Power Pucks*	*Robot*	***50***

	Land in assigned colored zone	*Field Landing Zone*	*Drone*	***100***
	Navigate through 1 large loop	*Drone Stunt Zone*	*Drone*	***150***
	Perform Aerial Stunt	*Drone Stunt Zone*	*Drone*	***200***
	Navigate through 1 small loop	*Drone Stunt Zone*	*Drone*	***250***
Autonomous – 01:00 minute	***Action***	***Element***	***Robot/Drone/ Lab***	***Points Each***
	Navigate through all three loops	*Drone Stunt Zone*	*Drone*	***700***
	Returning to the starting block area	*Field*	*Robot / Drone*	***100***

Table 1 – Autonomous Period Scoring

Teleop Period

Upon completion of the 60-second autonomous period, the remaining 4-minutes are considered a teleop (human control) period. Autonomous functions are not restricted during the teleop period; however, human operators must maintain hands-on control of the robot or drone during the 4-minute period. If autonomous functionality is used within the 4-minute teleop period, doubled points are not awarded.

TeleOp – 04:00 minutes	***Action***	***Element***	***Robot/Drone/ Lab***	***Points Each***
	STEM question	*#1, #2, #3, #4, & #5 STEM Question*	*Drone*	***125***
	Beacon activation	*Beacon*	*Drone*	***100***
	Collect colored pucks	*Pucks*	*Robot*	***25***
	Land in assigned colored zone	*Field Landing Zone*	*Drone*	***50***
	Navigate through 1 large loop	*Drone Stunt Zone*	*Drone*	***75***
	Perform Aerial Stunt	*Drone Stunt Zone*	*Drone*	***100***
	Navigate through 1 small loop	*Drone Stunt Zone*	*Drone*	***125***

	Navigate through all three loops	*Drone Stunt Zone*	*Drone*	***350***
	Returning to the starting block area	*Field*	*Robot / Drone*	***50***

Table 2 – Teleop Period Scoring

League Guidelines

League Overview

The Robot Drone League Jr. season runs from early September through January. RDL Jr. is a multi-week game where scoring elements and game themes change each year, and point values are adjusted to meet the requirements of the game. Teams should benefit from the guidance of teachers or mentors, with the constraint that only the students are the ones allowed to build, program, and operate the robot and drone.

Divisions

RDL Jr. consists of one division: Grades 1st – 5th

Team Organization

Teams may consist of an unlimited number of members; however, RDL Jr. recommends six to ten members per team. There is a limit of 4 players allowed in the driver's station during match play. Team members are allowed to substitute in as needed during a match, as long as there is never more than 4 team members at the drive station at one time.

RDL Jr. Team Showcase Review

On RDL Jr. competition day, teams will have an assigned showcase time. A maximum of ten minutes is allocated to allow for a team showcase review. The review is performed by a small team of volunteer judges that will meet the team at the RDL Jr. field for an opportunity to interview. For the first five minutes, teams are encouraged to uniquely present the engineering, functionality, programming and design of the robot and drone, as well as any information deemed important to share from the team. Teams are not limited in presentation style. The only requirements are that all team members are present and speak, and the team's robot and drone must be present. After the team has finished the five-minute presentation, judges are given an opportunity to ask questions for the remaining time. The RDL Jr. Team Showcase is designed to recognize teams with an opportunity to discuss important STEM ideas behind the teams' competition strategy, as well as how teams are impacting communities by the STEM example these students are setting. As an option, teams are allowed to include technical documents (less than 10 pages), reports, posters, and published materials to aid the RDL Jr. Team Showcase in support of the team's presentation to the judging panel.

For Rubric See Page 25

Engineering Notebook

An engineer's notebook is a book in which an engineer will formally document, in chronological order, all of his/her work that is associated with a specific design project. For RDL Jr., the engineering notebook serves a unique purpose in recording the teams' actions and discoveries throughout the RDL Jr. season. Although the engineering notebook is not required to officially compete or to participate in the RDL Jr. Team Showcase presentation (which is required), teams should know that the engineering notebook is strongly recommended.

The engineering notebook should have your team number and school name on the front cover. Engineering notebooks may contain other pertinent information such as community outreach, budgets, sponsorships, mentor notes, goals, and lessons learned. Each team session should be recorded with accurate dates and times of meetings. Team members contributing engineering notebook entries must initial all entries responsible for inclusion.

Illustrations and CAD diagrams are highly suggested. Only one notebook per team shall be submitted. Teams will leave notebooks with the judges' panel and must retrieve them prior to the end of the competition day.

Driver Station

The primary concern during any event is safety. To ensure the safety of all participants and observers, safety restrictions within the driver station must be followed at all times. The number of team members allowed in the driver station during a match is limited to four (4). Mentors are never allowed at the driver's stations during match play and are not permitted to "coach" from behind the crowd barrier. All players in the driver's station must be wearing closed-toe shoes, as well as safety glasses. Long hair must be pulled back and secured. No loose clothing or dangling jewelry is permitted.

Safety Check

The game has numerous scoring strategies which impact the design and construction of the team robots and the programming of the drones. Following the Four Laws of Robotics, safety is the primary concern for humans, robots, and drones related to inspection. Each robot and drone are required to successfully pass a safety check before competing in the tournament. To pass a safety check, robots and drones need to successfully meet the specifications defined below. If a robot or drone is not deemed safe, it will not be allowed to compete. After a robot and drone have passed safety checks, teams will be given a safety card that is required to bring with them to the assigned drivers station and present to the RDL Jr. official when competing in scoring matches.

SAFETY GLASSES ARE REQUIRED DURING DRONE AND ROBOT OPERATIONS.

Please note that when practicing for or competing in an event, safety should always be the priority. Unsafe operations of both robots and drones can result in serious injuries in the occurrence of misuse or malfunctions.

Robot Specifications

At this time, the only approved robot for use in RDL Jr. is the Sphero RVR or RVR+. Teams may use a smart tablet or laptop computer for controlling functions.

Drone Specifications

At this time, the only approved drones for use in RDL Jr. are the Tello EDU or Tello Talent. Teams may use a smart tablet or laptop computer for controlling functions.

Drone Color Cards

Teams will be given either a red or a blue index card (7.62 cm x 7.62 cm) at the start of each match with the hook side (spikey, rough side) of a Velcro piece to attach to the bottom of their drone, where they will have attached, the loop side (soft, fabric side) of another Velcro piece. This will be used for the drones to be able to illuminate the beacons to their respective alliance color.

Team Match Participation

Team Members

During a match, a team cannot use other participants outside of the driver station to guide robots or drones. If the team is viewed as using external participants to gain an advantage, a red card can be issued. Team members are not allowed on the field during a match and must remain in the driver station or pit at all times.

Under no circumstances shall a team member reach into the field. If the robot or drone is not working, the RDL Jr. official will place the robot or drone in the START / FINISH AREA for the remainder of the match.

Match Setup / Teardown

Before each match, teams have 2 minutes to set up the robot and drone. Teams will also have a 2-minute breakdown period after each match.

Field Reset

After each match, RDL officials will reset the field. This reset period lasts approximately five minutes. During this time, teams are required to remove their robots and drones from the field.

Penalties

Definitions

Yellow cards serve as warnings to teams. Red cards result in a minimum of fifty (50) points to a maximum of five hundred (500) point deduction from a team's score. A driver or pilot issued a red card is required to sit out the following match.

1. Following the intent of the Four Laws of Robotics, a robot may not purposely harm another robot, unless that somehow violates the First Law related to the safety of a human. The field is large, and it is expected that robots from each team will come in close proximity to each other. Robots should not intentionally contact another robot to play defense or prevent the other robot from accomplishing a task.
2. Purposely blocking a robot with another robot to prevent scoring or movement of the robot results in a yellow or red card, depending on any extenuating circumstances.
3. Drones that intentionally crash into a robot as a way to prevent scoring will result in a red card for the offending drone pilot. Drones that crash into an opposing robot are not eligible to be rescued during the match.

4. If a drone collision occurs, pilots are awarded a yellow card. If, in the opinion of a referee, a drone was intentionally crashed into another drone or did not show clear intent to avoid a collision, a red card may be issued for the offending drone's pilot.

Yellow Card

A yellow card serves as a warning for robot or drone behavior that is not in the spirit of the Robot Drone League. Any yellow card that is issued can be reviewed by league officials at the end of the match to determine if the actions of the robot or drone under the control of the driver were intentional to gain an advantage and disregard rules. If the league officials determine that the rule violation was intentional, it can be elevated to a red card.

Red Card

A red card issued for poor robot or drone behavior will result in the designated driver's absence in the next match, as well as a point deduction varying from fifty (50) to a maximum of five hundred (500) points from the offending team's final score. The driver / pilot is not allowed in the driver's station during the

next match. Teams may receive multiple red cards during a match and the final point deduction is solely at the discretion of the lead RDL Jr. official.

Excessive Mentorship

During an RDL Jr. event, if mentors, parents, or any adults are seen by a RDL Jr. Official actively working on a team's robot, a verbal warning will be issued and upon repeated violations, may result in the team's disqualification from competition matches and the withdrawal from any awards. Additionally, if judges/officials have suspicion of excessive mentorship which has affected the outcome of the design of the robot, the judges/officials have the right to conduct an investigation into a more thorough understanding of the team's knowledge of their own robot.

Awards

Regular awards for the 2023 RDL Jr. Season will be updated prior to the start of the Fall 2023 season.

Team Showcase Rubric

Content	Above Expectations (5 pts)	Meets Expectations (4 pts)	Progressing (2 – 3 pts)	Needs Improvement (0 – 1 pt)	Score
Engineering	Both robot and drone designs meet the challenges of the RDL Jr. field with thoughtful consideration for how the robot / drone interact with the field elements to achieve consistent scoring	The robot and / or drone designs meets the challenges of the RDL Jr. field with adequate solutions for how the robot / drone achieve success scoring elements	The robot and / or drone designs have mixed results when attempting retrieval of scoring elements	The robot and / or drone designs have minimal success and failed results when attempting retrieval of scoring elements	
Team Showcase Presentation	The team flawlessly articulated the teams mission purpose, robot and drone design rationale, community STEM engagement, and provided strong evidence of effective problem solving – ALL TEAM MEMBERS CONTRIBUTED	The team articulated the teams mission purpose, robot and drone design rationale, community STEM engagement, and provided good evidence of effective problem solving – Most of the team members contributed	The team provided partial evidence of mission purpose, robot and drone design rationale, and community engagement for the purpose of promoting STEM education – Some of the team members contributed	The team provided minimal or no evidence of mission purpose, robot and drone design rationale, and community engagement for the purpose of promoting STEM education – Two or less team members contributed	
Challenge Field Scores	>75% of all Division teams	>70% of all Division teams	>65% of all Division teams	>50% of all Division teams	
Competition Professionalism	<No occurrence of un-sportsmanship or poor behavior observed during competition				

Collaborative Spirit	Extreme team collaboration witnessed by judges and input from RDL Jr. staff and officials	Great team collaboration witnessed by judges and input from RDL Jr. staff and officials	Good team collaboration witnessed by judges and input from RDL Jr. staff and officials	Minimal or no team collaboration witnessed by judges and input from RDL Jr. staff and officials	

Sample STEM Questions

1) Professor Photon planted 3 trees in 9 minutes. How long did it take to plant each tree?

    a. 6
    b. 3
    c. 4
    d. 27

2) Which unit would you most likely use to measure the thickness of a sim card?

    a. millimeters
    b. meters
    c. centimeters
    d. kilometers

3) Which unit would you most likely use to measure the distance from the Earth to the Sun?

    a. millimeters
    b. centimeters
    c. meters
    d. kilometers

4) How long does it take the Earth to orbit the Sun?

a. 1 day
b. 1 month
c. 1 year
d. 24 hours

5) A magazine reports that a robot sent to Mars drilled on the surface to collect rock samples. What kind of technological instrument is the robot?

a. satellite
b. space observatory
c. space probe
d. spectroscope

6) What would be the best example of a body of water that contains saltwater?

a. Pacific Ocean
b. Tadpole Pond
c. Jordan Lake
d. Neuss River

7) How is a shadow created?

a. Objects blocking the path of light
b. Reflections
c. Darkness
d. Refractions

8) What happens according to Newton's 3rd Law if you let an untied balloon go?

a. The balloon will keep moving but the air will stop.
b. If you hit the balloon with your hand, the force will push your hand back.
c. Air will rush out of the balloon forcing the balloon to move through the air in the opposite direction, but equal in force.
d. Air will slowly seep out of the balloon forcing the balloon to move slowly through the air in the same direction, with ½ half of the force.