IEEE Region 5 Conference

Student Competitions Robotics Competition

2019 Competition Description and Rules

Change Log

Date	Comment
3/19/2018	v 1.0.0 First Rough Draft
4/13/2018	v 1.0.1 Second Rough Draft
5/17/2018	v 1.0.3 Third Rough Draft
8/3/2018	v 1.0.4 Forth Rough Draft
8/30/2018	V 1.1.0 Completed Rules

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Venue

Welcome to the 2019 Region 5 Robotics Competition Challenge. For detailed information regarding the venue and dates, as well as the practice boards, practice times, and competition times, refer to the Robotics Competition page on the Region 5 website.

Team Composition

This document contains the rules of the 2019 IEEE Region 5 Student Robotics Competition. The competition is open to teams of no more than 10 undergraduate students who are enrolled in a College or University within the IEEE Region 5 boundaries. The competition encourages a multidisciplinary approach to robot development and recognizes the participation of students who may already be members of other professional organizations (ACM, SAE, ASME, EEGS, etc.) Therefore, only one team member will be required to be a current IEEE Student Member. No students attending the hosting school may compete in the competition.

Events and Prizes

See Robotics Competition page on the Region 5 website.

Videotaping

Videotaping and photography will be allowed at the competition. Flash photography and the use of any light sources external to the robot will be prohibited during the competition.

Competition Description

The 2019 Competition will be a challenge to the strategist to build and program your autonomous robot to most efficiently complete a “simple” set of pick & place tasks.

One team member and judge will be within the designated play area. Other team members and viewers must be outside of the designated area. If a team member deliberately crosses into the area then the team is disqualified for that round.

Background

You and a team of astronauts have been given a mission to Mars, the Red Planet. The scope of your mission is to build a self-reliant rover to collect unique artifacts. These unique artifacts must be returned to the mothership that will then be sent back to Earth to be studied. Avoid the rocks, as they may hinder your rover from completing the mission. Good Luck and Safe Travels!

Overall Objective

The objective of the competition is for teams to demonstrate the use of an autonomous robot on a competition board with various set tasks to complete. The goal of the competition is to provide a challenge which combines readily understood tasks which begin in early rounds with relatively simple requirements for completion while providing a pathway to increasing complexity in later rounds. The intended aim of this competition design is to allow great flexibility in the way solutions are crafted so that teams with access to varying amounts of skill and resources can, with clever applications of strategy, be fully competitive.

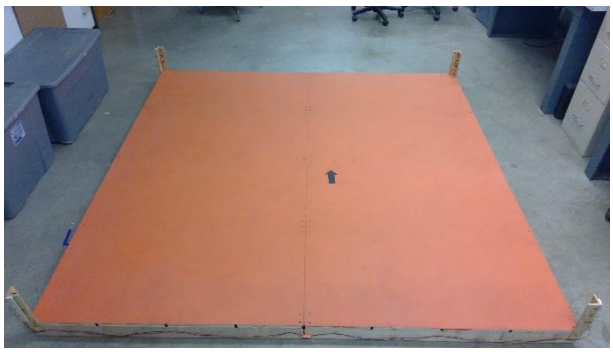
The Competition Board

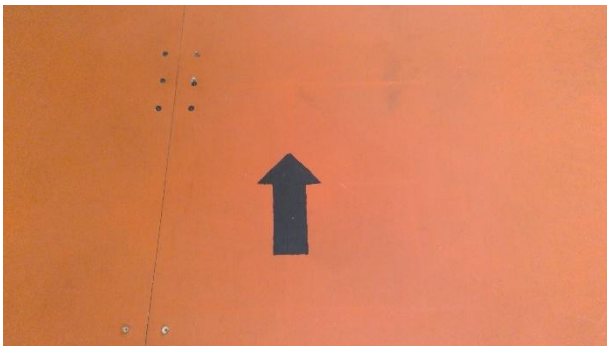
Specifications for the materials used in the construction of the competition boards are included in an appendix. The competition board, when assembled, will measure 8'x8'. The board will be made from two 4'x8' sheets of plywood. The playing surface will be painted as shown in Figure 1.

In Figure 1:

- The entire competition board is painted a copper oxide orange.
- There are no raises or elevated levels, other than the Two-by-Four studs that the board is built upon. Also, there are no walls along the edges of the board.
- There are black dashes along the "South" and "West" sides of the board, distinguishing between different 1'x1' squares. "South" and "West" are arranged in reference to the black arrow signifying "Mars North" that is at the middle of the competition board, this is an arbitrary direction all relative to the board itself. One black dash represents one foot.
- In square (4,4) there is a black arrow pointing "North" that teams can use to orient themselves at the start of a round.
- At the start of competition rounds the mothership will be placed on the board in a spot of random location and orientation. This information will not be given to teams.
- The obstacles for each round will be placed at pseudo-random locations and will not be given to teams.
- The blocks are to be placed pseudo-randomly for each round and the 1'x1' block in which they are placed will be given to teams in the form of a JSON file via USB.
- The location of the mothership, obstacles and blocks will be uniform between teams for each round.
- All obstacles and blocks will have a minimum of 6 inches of space between each other and from the mothership.
- Obstacles, blocks, and the mothership will be at least 6 inches from the edge of the competition board.
- Also, the obstacles, blocks, and mothership will not be within the 1'x1' starting area.

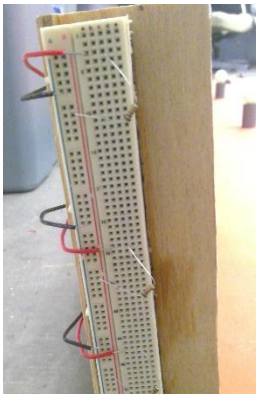
Figure 1: Competition Board Layout

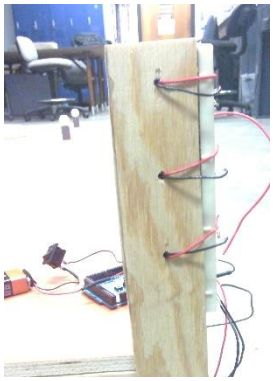




Corner Lights

Figure 2: Corner Lights





All directions are in reference to the "north" arrow.

- (250 Hertz "SE" Corner from arrow direction)
- (500 Hertz "SW" Corner from arrow direction)
- (750 Hertz "NE" Corner from arrow direction)
- (1000 Hertz "NW" Corner from arrow direction)

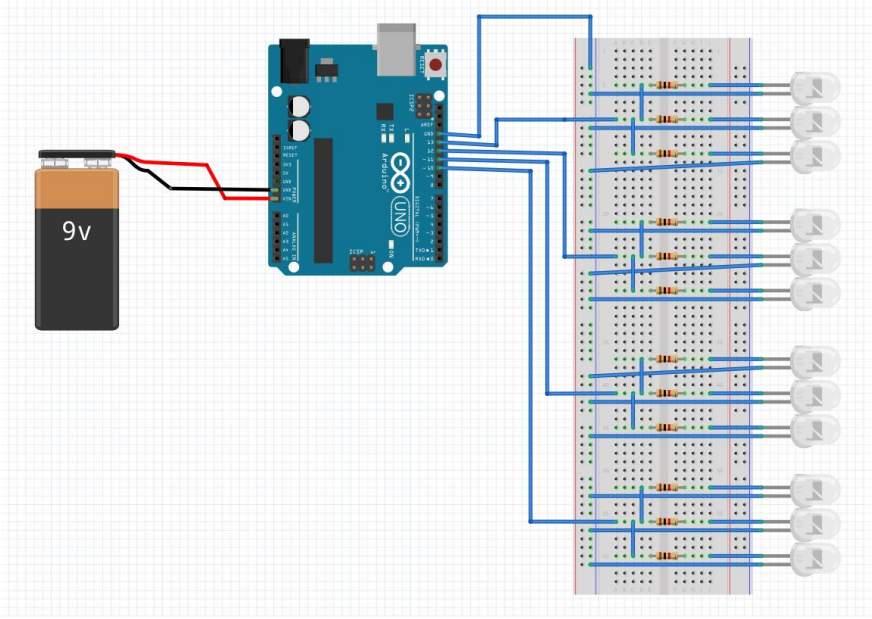
Duty Cycle: 50%

Voltage across the LED is 3 V

All Values for the Corner Lights have a 20% tolerance.

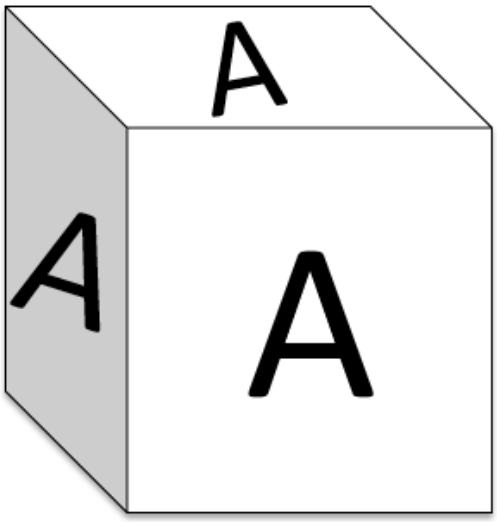
Select a resistor value to meet the tolerance/voltage requirements

Circuit for Corner Lights



Blocks

Blocks are to be wooden cubes with 1.5-inch edges on each side. Each block will have a specific character embedded on all sides. There will be six blocks with the characters A, B, C, D, E, and F on each block respectively. The block themselves will be painted white, with the characters being painted in black, using acrylic paint for both.



(Note: the characters will be present on every side of the block.)

Figure 3: Block

Obstacles

Obstacles will be wooden dowels with a 1.5 inch diameter and a 2 inch height. They will be cylindrically shaped. All obstacles will be painted grey. Obstacles will have a hole drilled through them vertically. A table tennis ball will rest on the top of the obstacle. The ball will have a diameter of approximately 1.57 inch and weigh approximately 0.095 oz. “Contact” with an obstacle is defined as the ball falling off the obstacle. If outside interference causes the ball to fall, “contact” will not be counted.

Figure 4: Obstacle

Mothership

The mothership will be a wooden construct. It will have an approximate 1 inch height with ramps on two opposing sides with an approximate 15° incline. On the sides without ramps, there will be six flashing green LEDs, with three LEDs on each opposing side. If two of the three LEDs on a side are functioning, the mothership will still be considered functional. If only one of the three LEDs or none of the LEDs are functioning on a side, the mothership will be considered non-functional and must be replaced. The mothership will also have six marked slots in which the blocks will be placed. They will be marked with the characters A, B, C, D, E, and F respectively. In Appendix B, Fig. C, the measurements of the mothership are provided.

Circuit for Mothership LEDs – Figure 5a

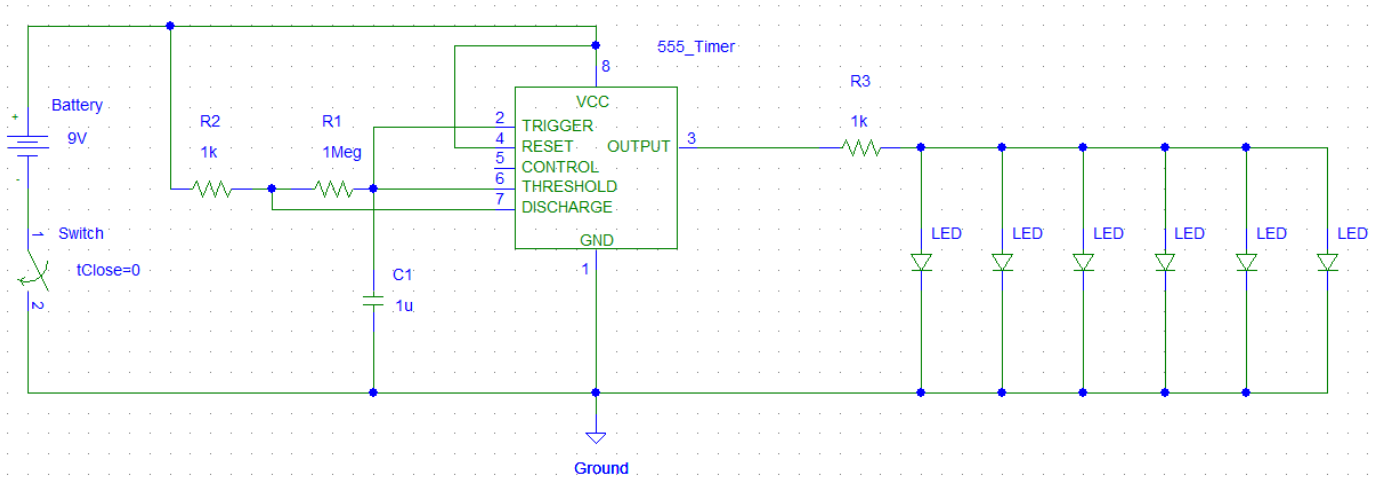


Figure 5b: Mothership

General Gameplay

There will be three rounds of competition with each round lasting 6 minutes. Each team will get one attempt per round. Scores will be cumulative over three rounds. The gameplay consists of the robot being placed in square (4, 4) on the competition board. When prompted by the judge, the player will start the robot and it will search for blocks on the board, identify characters on the block, and deposit the block in the appropriate slot on the mothership. During the round the robot must avoid obstacles placed on the board. Once the task is completed, the robot will return to the starting location at (4, 4).

- The robot must begin in the square (4, 4).
- Once the player presses the button to start the robot, any further outside interference with the robot stops the round, interference is up to the discretion of the judge.
- The robot should locate each of the blocks, identify the character on the block, and deposit each block in the corresponding marked slots, i.e. “A” block in “A” slot, etc.
- Judges can place blocks anywhere within the square foot of the (X,Y) location.
- Whenever a block is picked up, 5 points will be awarded. If the same block is repeatedly picked up, additional points will not be awarded. A block is considered as “picked up” when the block is in contact with the robot and not in contact with the competition board.
- If a block is placed by your robot in the correct slot, 45 points will be awarded.
- Any blocks that have not been picked up by the end of the round will be awarded no points.
- If all blocks are correctly placed in their marked slot, a bonus of 75 points will be awarded.
- The location of the obstacles will not be known beforehand.
- If contact is made with an obstacle 5 points will be deducted from the round, per obstacle.
- The mothership will be placed by he judges in a random location on the board each round.

- 30 points will be awarded if all robots return to the starting location at (4, 4) at the end of a round. Once returning to the starting location, the end of a round is signaled by the robot by turning on the finishing light or letting the timer reach 6 minutes.

Round 1

- 2 blocks and 5 obstacles will be placed on the board.
- The max score for Round 1 is 205 points.

Round 2

- 4 blocks and 10 obstacles will be placed on the board.
- The max score for Round 2 is 305 points.

Round 3

- 6 blocks and 15 obstacles will be placed on the board.
- The max score for Round 3 is 405 points.

Overall Score

The max score for the entire competition is 915 points. The highest cumulative score after three rounds wins.

Tiebreaker

- If teams are tied, the time of completion for all three rounds will be added together. The fastest total time will be declared winner. where total time is defined as the sum of all 3 round times times.

Miscellaneous Details

- If any robot touches the floor outside of the board, that robot may not be placed back onto the board.
- If all robots in play fall off the board, the round ends and a time of 6 minutes will be given. Teams retain any points accumulated prior to the round ending.
- If any part of a block or obstacle comes into contact with the floor outside the competition board, it may no longer contribute points to the round. If the block was picked up prior to falling off the board, the 5 points for picking up the block will still be counted, however, no further points will be received for that block.
- To receive points for a block, the placed block must be flush in the slots on the mothership. If the bottom of a block is not completely in contact with the bottom of the slot on the mothership by the end of the round, points will not be rewarded for that block.
- If for any reason a block is placed in a slot, and by the end of the round, the block is no longer in a slot, the team will be awarded no points for placing the block in the slot. Points will still be given for picking up the block.

- If all robots are idle for at least 10 seconds, the round ends, and six minutes will be assigned for that round's time.
- If a team interferes with their robot during an official round, other than pressing the start button, the round ends and 6 minutes are recorded for that round.
- If the mothership is knocked off of the competition board by a robot, the round will end, no points will be rewarded for that round, and six minutes will be assigned for that round.
- If the competition board or mothership is damaged by a competing team during their round, the round will end, and six minutes will be recorded for that round.

Robot Specifications and Rules

- The robots built for this competition are intended to be fully autonomous during gameplay. No communications to/from the robots are allowed during gameplay except for the start and stop buttons.
- All robots are required to have a finishing light to signal once they finish a round. Once a robot activates its finishing light, it will no longer earn any points for that round. If a robot activates its finishing light without returning to the starting location at (4, 4), the additional 30 points for returning to the starting location will not be rewarded. If a robot falls off the competition board, it is not required to activate a finishing light for the round to be completed. Finishing light must be placed at the highest point of the robot and visible to judges. It will be at the judge's discretion if the finishing light has turned on.
- All robots will be in quarantine starting 10 minutes prior to a round beginning. Robots will not be accessible to their team until the round is over. This also means that once a round of competition starts no teams can make changes or repairs to their robots
- Multiple robots may be used for this competition; however, all robots must fit within the 1'x1' starting area at (4, 4), at the start and end of the round.
- A robot or robots in the case of multiple robots, may together weigh no more than 40 pounds. Judgement on whether a robot qualifies for weight is at the sole discretion of the head judge.
- Chemicals or explosives – Explosives and volatile liquids are not permitted. Thus, gasoline engines are not permitted. Chemical batteries are allowed but only if used correctly and with appropriate safety and handling. Any robot deemed hazardous by the head judge may be disqualified.
- For this competition, robots are to move along the surface of the playing field. Wheeled, tracked, or legged robots are all valid. Flying robots, e.g. drones, are not allowed. Additionally, at least one wheel of each robot must be in contact with the competition board at all times.
- If any competing teams or related parties tamper with another competing team's robot, the tampering team will receive an immediate disqualification from the competition.
- Each team must bring their own equipment to prevent soldering droppings falling onto the hosting hotel's floor. The mat must cover up to one foot around the table used for soldering.

**Any and all measurements regarding the competition board, mothership, obstacles, and blocks will be given a 5% tolerance. Ie. length, width, height, weight, etc., unless a greater tolerance is specified herein.

Appendix A

Materials List

Material	Part Number	Website	Quantity
Black Paint	11002	https://www.hobbylobby.com/Crafts-Hobbies/Stencils-Craft-Paints/Acrylic-Craft-Paints/Black-Anita's-Acrylic-Craft-Paint---2-Ounces/p/605	1
White Paint	1026833	https://www.lowes.com/pd/Krylon-Colormaxx-General-Purpose-Flat-White-Spray-Paint-Actual-Net-Contents-12-oz/1000459761	1
Gray Paint	1026759	https://www.lowes.com/pd/Krylon-Colormaxx-General-Purpose-Matte-Deep-Gray-Spray-Paint-Actual-Net-Contents-12-oz/1000459529	1
Stencil	825588	https://www.hobbylobby.com/Crafts-Hobbies/Stencils-Craft-Paints/Stenciling/1-Upper-Lower-Case-Alphabet-Stencil---Roman/p/27049	1
Blocks	165670	https://www.hobbylobby.com/Crafts-Hobbies/Painting-Surfaces/Wood/Birch-Wood-Cubes---1-1-2%22/p/23049	1
Dowel	43821	https://www.lowes.com/pd/Madison-Mill-Round-Wood-Poplar-Dowel-Actual-48-in-L-x-1-5-in-dia/3042000	1
Table Tennis Balls	T1412	https://www.walmart.com/ip/STIGA-1-Star-Table-Tennis-Balls-38pk/20657271?wmlspartner=wlpa&selectedSellerId=0&adid=22222222227014935445&wl0=&wl1=g&wl2=c&wl3=52285369815&wl4=pla-79368828255&wl5=9025237&wl6=&wl7=&wl8=&wl9=pla&wl10=8175035&wl11=online&wl12=20657271&wl13=&veh=sem	1
Oak Plywood	6211	https://www.lowes.com/pd/1-4-in-Oak-Plywood-Application-as-2-X-4/1000066207	2
Wood Glue	88042	https://www.lowes.com/pd/Gorilla-Wood-Glue-Off-White-Interior-Exterior-Wood-Adhesive-Actual-Net-Contents-8-fl-oz/3121069	1
1’’ Screws	772846	https://www.lowes.com/pd/Grip-Rite-8-x-1-in-Bugle-Head-Coarse-Thread-Drywall-Screws-1-lb/999959981	1
Poultry Net Staples	69217	https://www.lowes.com/pd/Grip-Rite-3-4-in-Leg-Standard-Staples-1-lb/3043059	1
Green LED’s	COM-08285	https://www.sparkfun.com/products/8285	1

Black Wire	22UL1007 SLDBLA	https://www.amazon.com/Remington-Industries-22UL1007SLDBLA-Hook-Up-Diameter/dp/B010T5Y6PU/ref=sr_1_fkmr0_1?ie=UTF8&qid=1535687029&sr=8-1-fkmr0&keywords=remington+industries+22ul1007	1
Red Wire	22UL1007 SLDRED	https://www.amazon.com/Remington-Industries-22UL1007SLDRED-Hook-Up-Diameter/dp/B010T5YOR0/ref=pd_bxgy_328_img_2?_encoding=UTF8&pd_rd_i=B010T5YOR0&pd_rd_r=29a1ba9a-acd0-11e8-a16e-f165ee31ead5&pd_rd_w=1SY9Q&pd_rd_wg=5YXJE&pf_rd_i=desktop-dp-sims&pf_rd_m=ATVPDKIKX0DER&pf_rd_p=7ca3846a-7fcf-4568-9727-1bc2d7b4d5e0&pf_rd_r=8YT37BFY9J4QF4YDKYX6&pf_rd_s=desktop-dp-sims&pf_rd_t=40701&psc=1&refRID=8YT37BFY9J4QF4YDKYX6&dpID=518mecUimcL&preST=_SX342_QL70_&dpSrc=detail	1
Bread board	PRT-12002	https://www.sparkfun.com/products/12002	5
Switch	75666	https://www.lowes.com/pd/SERVALITE-Switch-Single-Pole-Metal-Light-Switch/3379484	2
9V Battery	99500	https://www.lowes.com/pd/Duracell-4-Pack-PP3-9v-Alkaline-Battery/999998138	1
9V Connector	PRT-00091	https://www.sparkfun.com/products/91	2
555 Timer	COM-09273	https://www.sparkfun.com/products/9273	1
Capacitor	KIT-13698	https://www.sparkfun.com/products/13698	1
Resistors	COM-10969	https://www.sparkfun.com/products/10969	1
Electrical Tape	45849	https://www.lowes.com/pd/Scotch-Super-33-66-ft-Electrical-Tape/3138881	1
Plywood	520359	https://www.lowes.com/pd/Top-Choice-Blondewood-1-2-in-Whitewood-Plywood-Application-as-4-X-8/50121137	2
2x4's	6003	https://www.lowes.com/pd/Common-2-in-X-4-in-x-92-5-8-in-Actual-1-5-in-x-3-5-in-x-8-ft-Whitewood-Pre-cut-Stud/1000525943	6
2'' Screws	112594	https://www.lowes.com/pd/Grip-Rite-6-x-2-in-Bugle-Head-Coarse-Thread-Drywall-Screws-1-lb/4744167	1
Orange Paint	NA	Description of Paint: Olympic, Gallon, HGSW1113,	1

		COLOR: OXIDE COPPER Flat, ASSURE Interior Paint and Primer	
Blue LED's	100F5T-YT-WH-BL	https://www.amazon.com/Transparent-Lighting-Electronics-Components-Emitting/dp/B01AUI4VYW/ref=sr_1_1?ie=UTF8&qid=1535686936&sr=8-1&keywords=chanzon+100+pcs+5mm+blue	1
Wire Connectors	30-1302S	https://www.homedepot.com/p/Ideal-PowerPlug-Orange-Ballast-Disconnect-Discs-5-Pack-30-1302S/202935637	1
Arduino Uno	DEV-11021	https://www.sparkfun.com/products/11021	1
Super Glue	389	https://www.lowes.com/pd/Gorilla-20-Gram-Super-Glue-Multipurpose-Adhesive/3033016	1
Hinges	803710	https://www.lowes.com/pd/Gatehouse-4-Pack-1-in-X-1-in-Oil-Rubbed-Bronze-Surface-Broad-Cabinet-Hinge/1000141897	1

Appendix B
Field Build Instructions

Competition Board:

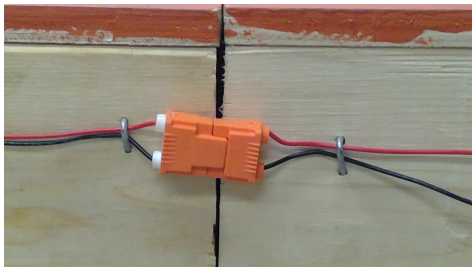
1. Take 5 of the 6 pieces of 2x4 and cut them into two equal 4 feet long pieces.
2. Place 5 of the new pieces in parallel with the 4 foot side of the plywood. The outer two should be flush with the edge of the plywood. The center of the other three should be located at 2 feet, 4 feet, and 6 feet of the plywood respectively.
3. Screw the plywood to the 5 2x4's on each end.
4. Repeat steps 2 and 3 for the other 5 pieces of 2x4 and the other sheet of plywood.
5. Measure the distances between each supporting 2x4 under the plywood.
6. Cut the remaining 2x4 to these 4 measurements. They will be positioned with the wider side in contact with the plywood. These are used to connect the two halves of the board together and guarantee a flush center.
7. Use the 2 inch screws and secure the pieces of 2x4 to each piece of plywood at either end of the 2x4.
8. Paint top of plywood with the copper oxide orange paint using the roller. One to two coats maximum.
9. Measure and mark each foot of the 8 feet on the side of the plywood.
10. Paint each mark using the tube of black paint. This is to help visualize the layout when placing blocks or obstacles.
11. In the center of (4,4) paint a black arrow pointing toward one side of the board. This tip of the arrow signifies north and will be used in reference when installing the lights.

Figure A: Underneath of Competition Board

Corner Lights:

1. Cut 8 - 2 inch x 10 inch pieces of the ¼ inch thick oak plywood.
2. Take two pieces and glue them together long ways at a 90 degree angle.
3. On the piece of wood on the right side of the 90 degree angle, in the center of it, measure and drill a hole big enough to fit two pieces of wire at 5, 7, and 9 inches from the bottom.
4. Put a poultry net staple at the bottom of each hole.
5. Secure a piece of breadboard, with the super glue, to the back of the piece of wood on the left side of the 90 degree angle.
6. Feed one blue LED, with wires soldered to them, through each hole.
7. Secure each blue LED to the poultry net staples with electrical tape. Be sure to face the blue LEDs toward the center of the project board.
8. Construct the circuit for the blue LEDs on the breadboard.
9. Screw the corner light assembly to a corner of the competition board with two inches of the assembly below the surface of the competition board.
10. Repeat steps 2 - 9 for the remaining three corners.
11. Run the ground and pin wire from each corner along the side of the competition board to the corner with the Arduino Uno. Secure the wire to the board with the poultry net staples.
12. At the point where the wires cross the seam of the competition board, cut the wires and reattach them with the wire connectors.
13. Complete the circuit to the Arduino Uno.
14. Cut the end of the 9V connector off and solder the black wire to one of the wires on the switch. Use this to easily power your Arduino Uno with a 9V battery.

Figure B: Wire Connector

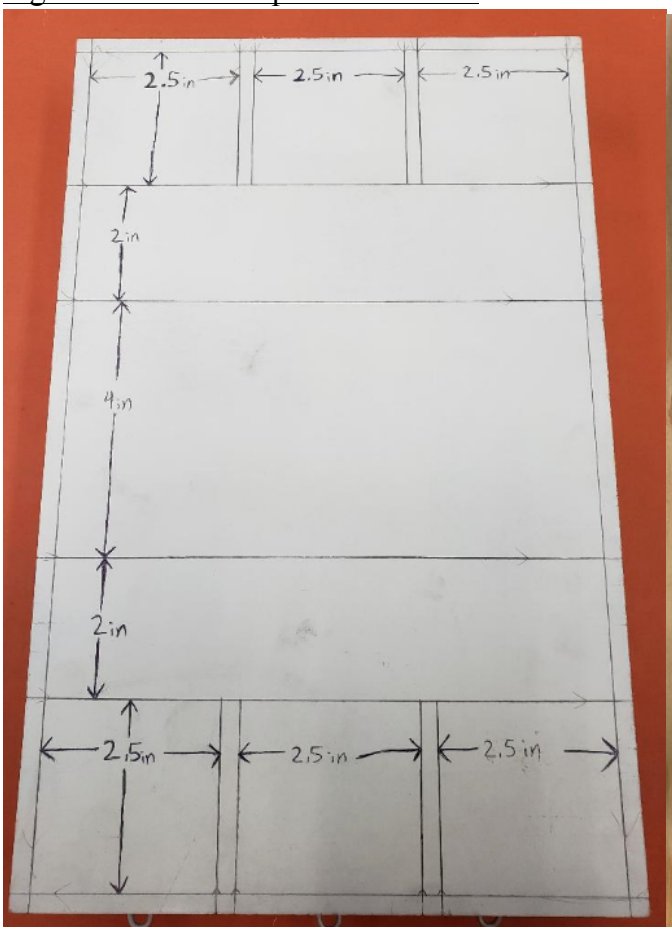


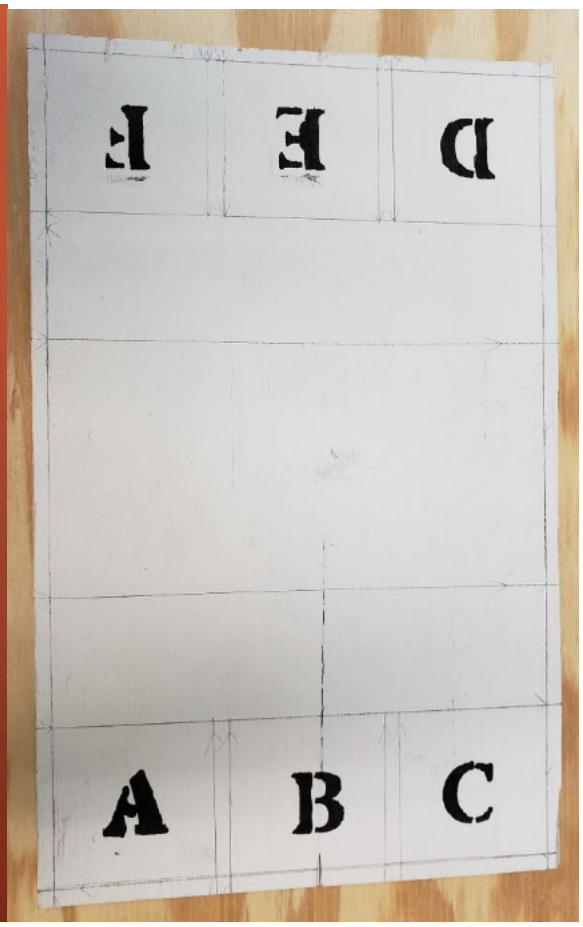
Mothership:

1. Using the ¼ inch thick oak plywood cut:
    a. 1 - 8 ½ inch x 13 ½ inch
    b. 2 - 8 inch x 6 ¼ inch
    c. 4 - 4 ½ inch x 1 ¼ inch
    d. 4 - 2 ½ inch x 1 ¼ inch
    e. 2 - 8 ½ inch x 1 ¼ inch
    f. 6 - 8 inch x 2 inch

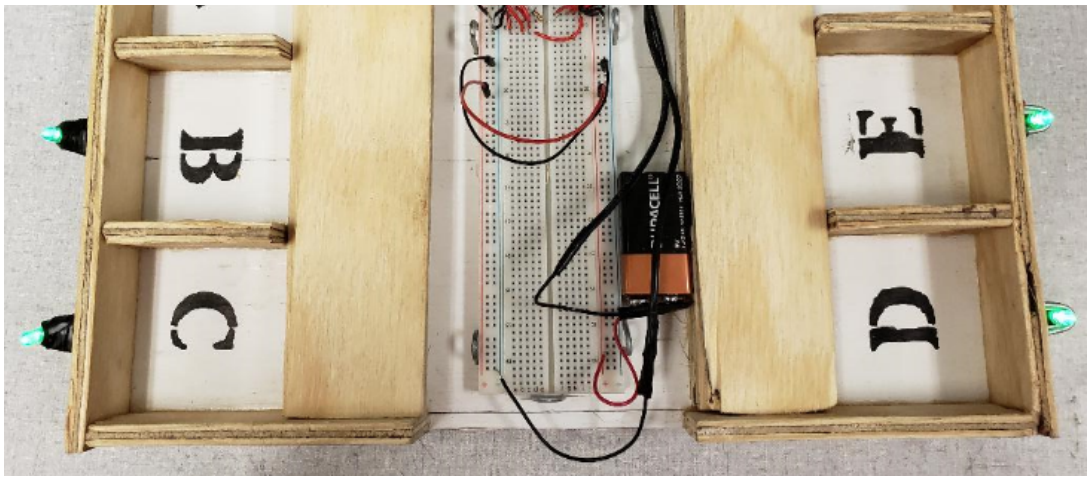
   g. 1 - 8 inch x 8 inch
2. Take piece “a” and paint 1 side with white spray paint.
3. Draw the outlines of the ¼ inch walls to the measurements in the picture.
4. Paint the letters A - F, with the stencils, in the center of each 2.5 inch x 2.5 inch square as shown in the picture.
5. Glue piece “e” vertically on each of the shorter ends of piece “a”.
6. Glue piece “d” vertically on left and right side of each middle 2.5 inch x 2.5 inch square next to and perpendicular to piece “e”.
7. Glue piece “c” vertically on the outside edge of the 2.5 inch x 2.5 inch squares, parallel to piece “d”, next to and perpendicular to piece “e”.
8. Take three pieces of piece “f” and glue them horizontally in between piece “c” on both sides with one side flush against piece “d”.
9. Secure the breadboard and switch to piece “a” in between the two stacks of piece “f”.
10. On the outside wall of the slots for the blocks, put a poultry net staple a ¼ from the top in the center of each slot. Tape a green LED with wires soldered to it to each poultry net staple. Be sure to face the green LEDs in the up direction.
11. Wire the green LEDs and the circuit to the breadboard. Use the switch, 9V connector, and 9V battery to power the circuit.
12. Screw piece “g” at each corner on top of the two stacks of piece “f”.
13. File down one of the 8 inch sides of piece “b” to a 15 degree angle and the other 8 inch side to a 75 degree angle. These will be the ramps for the mothership.
14. With the hinges secure the 75 degree angle of piece “b” to the mothership as shown in the picture.

Figure C : Mothership Build Pictures





*Narrow spaces are ¼ inch thick



Blocks:

1. Sand each side of the block slightly in order to give the paint a rougher surface to adhere to.
2. The blocks are then to be painted white using the can of spray paint. Two to three coats maximum.
3. After the paint dries use the stencils A-F, and using the tube of black paint, place a single letter on each side of the block, ie. an A on each side of the first block etc.

Obstacles:

1. Take the dowel and cut 15 2 inch long pieces.
2. Drill a ⅝ inch hole in the center all the way through the 2 inch piece.
3. Paint each of the 15 pieces using the can of grey spray paint. Two to three coats maximum.
4. After the paint has dried, place the ping pong ball on the ⅝ inch hole that was drilled.