2027 Robotics Middle School

Overview:
The objective for this challenge is to design, build, and operate a robot that can maneuver through field obstacles to collect Scoring Objects and successfully score them into designated Goals within the Scoring Zone. The challenge is completed with only one (1) robot on the field at a time and a maximum allotted time of ten (10) minutes. The challenge is designed to test the handling, maneuverability, hardware capabilities, and driving skills of your robot through various terrain obstacles by collecting and scoring differently sized and shaped Scoring Objects. Optional bonus points will be available for ending the challenge in the Ending Zone. Teams are encouraged to research, design, prototype, and test their robots so that they can successfully maneuver through the course and obstacles and gather the objects to deliver to the Scoring Zone.

Procedure

- **Check-In, Inspection, Pit Setup, Practice:** Upon arrival at the assigned time, teams will check-in, present their robot for a safety inspection, and sign up for a challenge run time. Once cleared by judges, teams may set up their pit area and utilize designated practice areas. Teams will also have an opportunity to view the official field layout for strategic planning.
- **Pre-Challenge Briefing:** A mandatory drivers' meeting (maximum 30 minutes) will take place prior to event runs. Teams will have the opportunity to ask the event coordinator clarification questions regarding field rules or procedures.
- **Run Time & Clock:** Teams are allotted a ten (10) minute running clock to execute their run. The clock is started by the judges and stops either when a member of the team requests the run to be over or when the 10-minute time limit expires.
- **Final Score & Field Reset:** At the conclusion of the run, judges will verify and record the points from scored objects and any bonus points. Teams will assist field personnel in resetting the course for the next competitor.
- **Semifinal Interviews:** The top twelve (12) preliminary scoring teams will advance to the semifinal round for a ten (10) minute team interview. Combined run and interview scores will determine the final standings.

Field Setup & Layout

- **Competition Field:** The course is an approximate 10' x 10' square field enclosed by a 1-inch PVC pipe perimeter. Robots must operate strictly within the boundaries of the field perimeter. Build instructions will be provided in the appendix.
- **Starting Zone:** A designated 16” x 16” Starting Zone is located within the field perimeter, serving as the starting location and reset point for the robot. Tape will be used to define the Starting Zone perimeter.
- **Scoring Zone:** A designated area on the field containing the Goals where Scoring Objects must be placed. Tape will be used to define the Scoring Zone perimeter.
- **Obstacle Zones:** The field is partitioned into four (4) distinct Obstacle Zones, each featuring a specific terrain obstacle that robots must navigate around or through. All obstacles are set up in identical locations and orientations for every team.

- **Scoring Objects:** A total of twelve (12) Scoring Objects will be placed across the field within the Obstacle Zones. Each Obstacle Zone will have three (3) different Scoring Objects. No scoring objects of the same type will be placed in the same Obstacle Zone. Each scoring object is worth ten (10) points when placed in the appropriate Goal. Scores are determined after the run has concluded. Scoring object placement and orientation is determined by the event coordinator prior to the competition, and placement/orientation will be identical for every team.
- **Goals:** Each Scoring Object corresponds to a specific Goal within the Scoring Zone where the object must be successfully scored. Goals must remain within the Scoring Zone but may be moved or rearranged, in the zone, by robots during the run. Robots are allowed to enter the taped section of the Scoring Zone to interact with Goals. All Goals are set up in identical locations and orientations for every team. Scoring is determined at the end of the run. Any Goal that is partially or fully outside the Scoring Zone at the end of the run, will not be counted in the score. Any Goal partially or fully outside the Scoring Zone, at any time, will also be given a Scoring Zone Penalty (see Penalties & Deductions section).
- **Optional - Ending Zone Bonus:** A designated Ending Zone is located within the field perimeter. This location will be defined by a 24” x 36” plywood sheet 1/4” thick known as the Hills and Valleys. Robots that end the run in the Ending Zone will receive a fifteen (15) point End Zone Bonus. No penalty is assessed for robots that do not end in the Ending Zone. To receive the End Zone Bonus robots must be completely inside the plywood area. If any part of the robot extends beyond the 24”x 36” plywood perimeter, as viewed from above, the robot will not receive the End Zone Bonus. Robots must remain in the Ending Zone for judges to confirm or deny the bonus at the end of the match.
- **Field Tolerances:** Competition Field dimensions, obstacle placement, and zone boundaries are approximate and may vary slightly due to venue conditions and construction tolerances. Minor variation across fields or events is permitted and does not invalidate a run.
- **Tape & Boundary Conventions:** Tape may be used by the event coordinator to secure the Competition Field and Obstacles, or to mark starting locations of Scoring Objects, Goals, and Obstacles. Tape will also be used to outline the boundaries for the Starting Zone and Scoring Zone. The inside edge of the tape defines the boundary of the zone (the tape itself is considered outside the zone). Tape lines may be crossed by robots at any time during the run.
- **Measurement:** All dimensional measurements for this event are in inches.

Gameplay Rules

- **Schedule:** Judges and coordinator will work to keep runs on schedule. All teams must be prepared to become “off schedule” due to unexpected delays. If a team fails to have their robot ready to compete at their scheduled start time the team will forfeit their run and receive zero (0) points. The coordinator may allow teams to compete at his/her discretion.
- **Team members only:** Only Robotics Team members are allowed in the pit area, practice area, and competition area. A dedicated viewing area will be for advisors, friends, family, etc. to watch.
- **Maximum Size:** Robots must fit into a 16” x 16” x 16” cube at the start of the run. Once the run begins that robot may expand outside the starting volume.
- **One Robot:** The robot must consist of one single entity. Sub-assemblies that split from the main structure, secondary mini-bots, or detachable units (tethered or untethered) are strictly prohibited.
- **Starting the Run:** Teams will quickly place their robots on the playing field in the Starting Zone where judges will complete a final check of size and any Safety concerns. Judges will begin the run by giving a countdown such as “3-2-1 Go”. At that time the clock will start and robots will be able to leave the Starting Zone.
- **Ending the Run:** Robot operation will stop when 1) a team member requests the clock to stop by saying “Stop Clock” or similar phrase or 2) the ten (10) minutes have expired. Run time will be recorded. In the case of a tie in points, the team with the faster time will be ranked higher.
- **Control:** Drivers may control the robot visually (line-of-sight) or camera operated FPV (first-person view) control methods. The number of drivers is not limited, anyone on the team may drive at any time. Drivers may move anywhere around the outside perimeter of the Competition Field during the run. Drivers must control the robot remotely; robots and driver controls must be “untethered”. Drivers may use any remote control device (e.g., controller, keyboard, RC transmitter, etc.).
- **Spotters:** Any team that is not actively controlling the robot is considered a spotter. There is no limit to the number of spotters as any team member not driving may be a spotter. Spotters may move anywhere around the outside perimeter of the Competition Field during the run. Spotters are able to communicate to drivers at any time during the run. Anyone in the viewing area is considered a viewer only and should not communicate to drivers or spotters.
- **Possession Limit:** A robot may carry, hold, or retain control of only one (1) Scoring Object at a time. A robot is considered to be in possession of an object if the object is fully supported, trapped, or actively controlled by a mechanism. Incidental contact while pushing or driving past objects on the field floor does not count as possession.
- **Goal & Object Handling:** Scoring Objects must be collected from within their respective Obstacle Zones and placed into Goals located in the Scoring Zone. If a Goal is moved out of the Scoring Zone, partially or fully, any Objects in that Goal will not be scored. If a robot is touching any Object(s) or Goal(s) at the end of the run, no points will be awarded for any Objects in that Goal.
- **Goal Movement:** Robots are permitted to move, reorient, or relocate Goals within the boundaries of the Scoring Zone during their run. However, Goals must remain completely within the Scoring Zone perimeter at all times.

- **Driver Control & Field Station:** All team members must remain around the outside perimeter of the Competition Field during the entire 10-minute run. If a robot needs to be physically touched by a team member for any reason the robot must be placed back into the Starting Zone. If the robot was in possession of any Scoring Object, that object will be deemed “Dead”, removed from the run and will not be scored.
- **Dead Objects (Out of Bounds):** If a Scoring Object goes out of the field perimeter during a run for any reason, it is deemed a "Dead Object." Dead Objects will not be re-entered onto the field or eligible for points.
- **Scoring Objects:** Robots must collect Scoring Objects from within their specific Obstacle Zones. Reaching or traveling over Obstacle Zone PVC dividers to acquire or return Scoring Objects from adjacent zones is strictly prohibited. If an object inadvertently is moved from one Obstacle Zone (1st) to another Obstacle Zone (2nd) the robot will need to go to the 2nd Obstacle Zone to retrieve it (no reaching over to acquire objects).
- **Obstacle Location:** Robots are to navigate obstacles to obtain Scoring Objects. Obstacles are not to be moved. Robots may contact obstacles but are not able to move obstacles. If a robot moves an obstacle then Obstacle Penalty is assessed. Coordinators may use tape to fasten obstacles or to place markers for obstacles to be returned to starting locations for each run.
- **No Outside Objects:** No outside objects may be used in the competition field.
- **Contact with Field:** Robots must maintain physical contact with the competition field surface at all times (except if performing a Hanging Bonus). Brief, incidental loss of contact (e.g., wheels lifting due to terrain) is allowed. Intentional jumping, flying, or hovering is prohibited.
- **Batteries:** Batteries must meet all requirements as outlined in the competitive events guide. Battery packs should only be connected in the pit area, practice area, or competition field.
- **Safety:**
    - All team members should, at a minimum, wear eye protection and safety vests (in addition to TSA competition attire) when in the pit area, practice area, or competition area. Coordinators will dedicate an area for viewing. Anyone in the viewing area will not be required to wear eye protection or safety vests.
    - Teams are not allowed to use any tools which would emit sparks or material (e.g., Dremel/Rotary Tools)
    - Robots should not damage Scoring Objects, Obstacles, or the Competition Field. Robots should not be designed or operated in a manner that would cause damage to people or objects.
    - Any team violating safety rules may be assessed a score penalty or forfeit their run.

Penalties & Deductions

Penalties will be assessed by field judges and deducted from the team's total score at the end of the run.

- **Delay Penalty (-10 Points per occurrence):** A Delay Penalty is assessed when teams do not timely prepare their robots for their run causing a delay for the schedule. Examples: Teams are called but do not come to the Competition Field in a timely manner, Teams have their robot in the Starting Zone but are resizing or repairing their robots.
- **Human Interaction Penalty (-10 Points per occurrence):** Any intentional or unintentional physical contact between a team member and the robot while the clock is running results in a ten (10) point deduction.
- **Field Perimeter Penalty (-10 Points per occurrence):** Robots must remain inside the competition field. Robots that travel over the PVC field perimeter will receive a penalty of ten (10) points per occurrence. Robots are deemed outside the competition field if any part of the robot touches the ground outside of the PVC pipe perimeter.
- **Over-Possession Penalty (-5 Points per extra object per occurrence):** Possession of more than one (1) Scoring Object simultaneously will incur a five (5) point deduction per additional object for each occurrence.
- **Obstacle Penalty (-5 Points per occurrence):** Obstacles may be contacted but are not to be moved. A 5 point penalty is assessed for any obstacle that is moved. Note: Trees have a separate penalty.
- **Tree Obstacle Penalty (-1 Point per tree):** Tree obstacles that fall are assessed a one (1) point penalty per tree. If the forest base is moved the standard five (5) point penalty will be assessed.
- **Obstacle Zone Penalty (-5 Points per occurrence):** Robots are restricted to the zone they are in and may not cross the PVC boundary. A penalty will be assessed each time a robot physically contacts the floor, an obstacle, or a scoring element located in an adjacent zone. Note: Robots may break the vertical plane (hang over) into an adjacent zone without penalty, provided no physical contact is made
- **Scoring Zone Penalty (-5 Points per occurrence):** Robots that move a Goal outside the Scoring Zone will receive a five (5) point deduction per occurrence. Note: Goals will only be scored if they are completely inside the Scoring Zone.
- **Disqualification (DQ):** Severe safety violations, such as intentionally throwing objects outside the field perimeter, hazardous electrical/mechanical hazards, or blatant refusal to follow judge instructions, will result in an immediate stop of the run and a score of zero (0) for the attempt.

Scoring Objects

Scoring Objects will be similar to the ones as follows.

Note: 3 of each for a total of 12 Scoring Objects

- Wooden Eggs
- Cones
- Rings
- Foam Dice

Goals

- **Egg Carton** - Wooden eggs to be placed in a cardboard dozen egg carton with no top flap/cover. The egg has to be placed in a position for a singular egg but may be oriented in any direction.
- **6-quart storage bin -** Foam Dice will be placed in a 6-quart storage bin. The box will be open with no top/lid.
- **Base Cone** - Cones must be stacked on top of the base cone located in the Scoring Zone (or onto an already stacked cone). A single cone (Base Cone) will start in the Scoring Zone with the other three placed in the Obstacle Zones.
- **Ring Post Stand** - Rings will be placed on the center vertical pipe of a PVC Ring Post Stand. See Ring Post Stand build instructions at the end of this document.

Note: Goals may change orientation during the run. Points are awarded for the Scoring Objects that meet the criteria above, Goal orientation does not matter.

Obstacles

See build instructions, at the end of this document, for each obstacle.

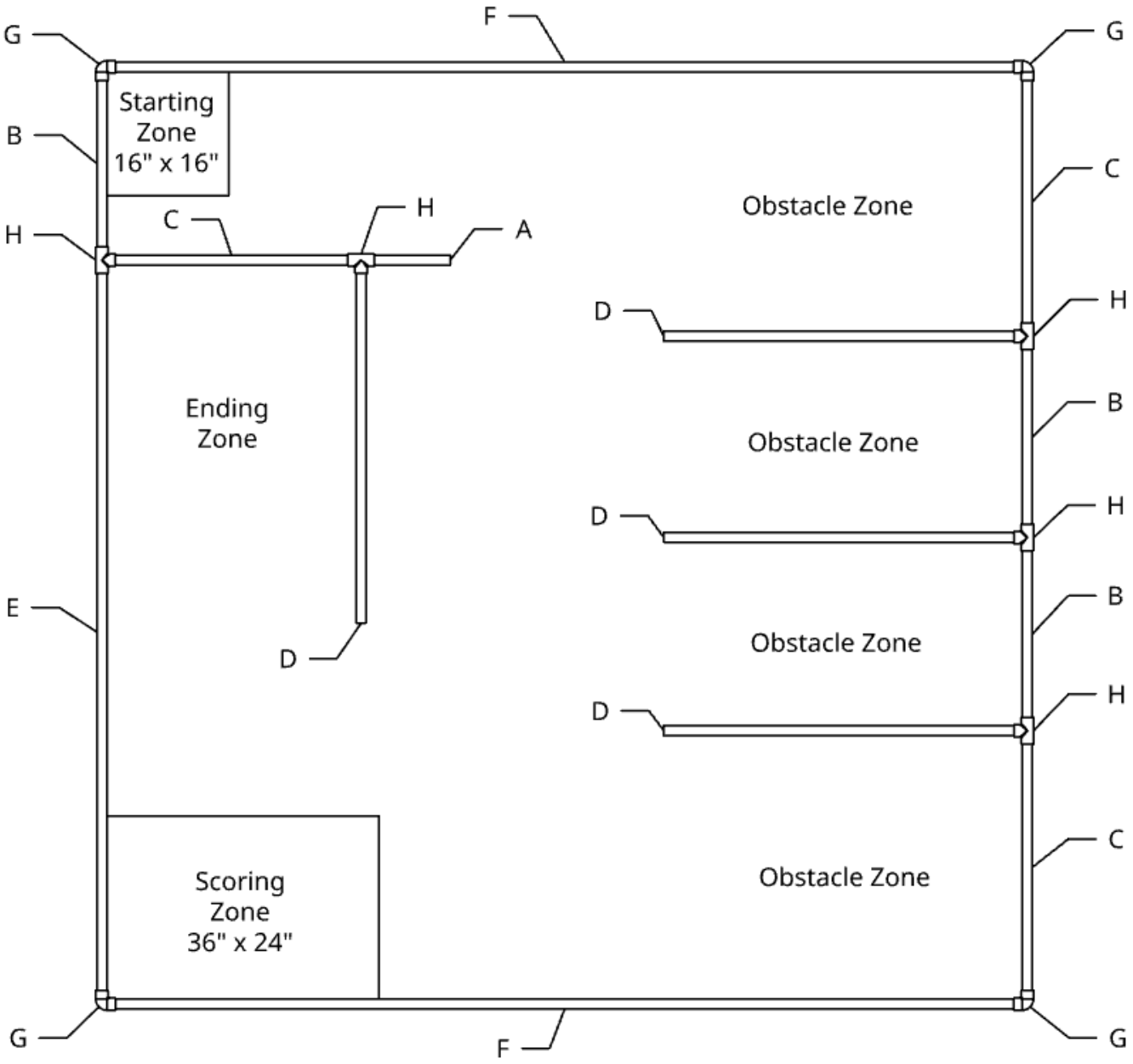
- **The Meadow** - 24”x36” Turf Grass 1”-1.5” tall
- **The Forest** - 10 pieces of 1/2” x 8.5” long PVC pipes standing on end in a wooden base.
- **The Table** - Made of 1/2” PVC and a piece of 1/4” plywood cut to 12” x 24”. Zip ties (cable ties) are used to connect the table top to the legs.
- **Hurdles** - Two (2) Hurdles, made of 1/2” PVC, the robot must pass under to get to the Scoring Objects..

Bonus

Build instructions will be provided in the appendix

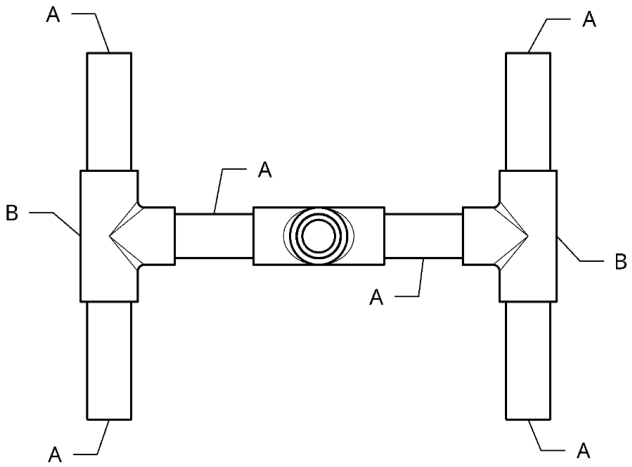
- **Hills and Valleys** - Made of wood mounted to a piece of 1/4” plywood cut to 24” x 36”. Alternatively, the hills may be 3d printed and placed on 1/4” plywood.

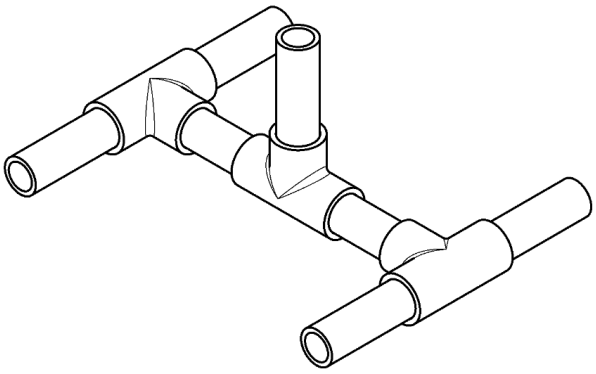
Competition Field

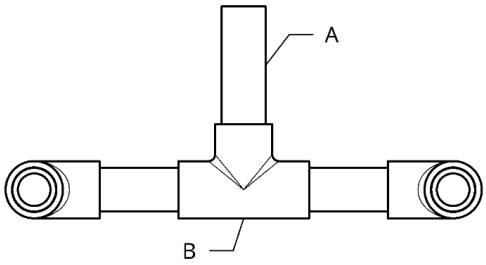


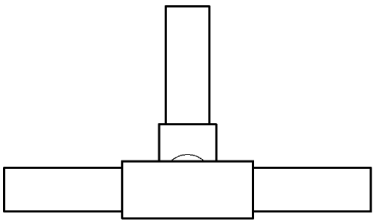
Item	Qty	Description	Size
A	1	1” SCH40 PVC Pipe	11” x 1”
B	3	1” SCH40 PVC Pipe	24” x 1”
C	3	1” SCH40 PVC Pipe	34” x 1”
D	4	1” SCH40 PVC Pipe	47” x 1”
E	1	1” SCH40 PVC Pipe	96 7/8” x 1”
F	2	1” SCH40 PVC Pipe	120” x 1”
G	4	1” SCH40 PVC Elbow	
H	2	1” SCH40 PVC Tee	

Ring Post Goal





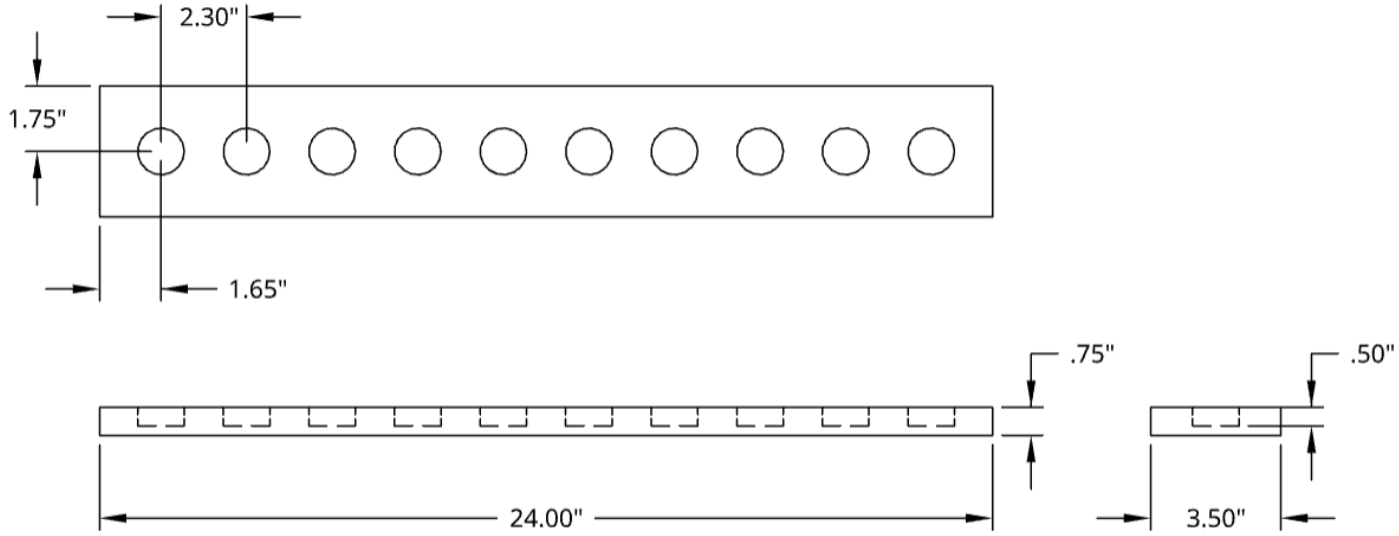




Item	Qty	Description	Size
A	7	1/2” SCH40 PVC Pipe	3” x 1/2””
B	3	1/2” SCH40 Tee	

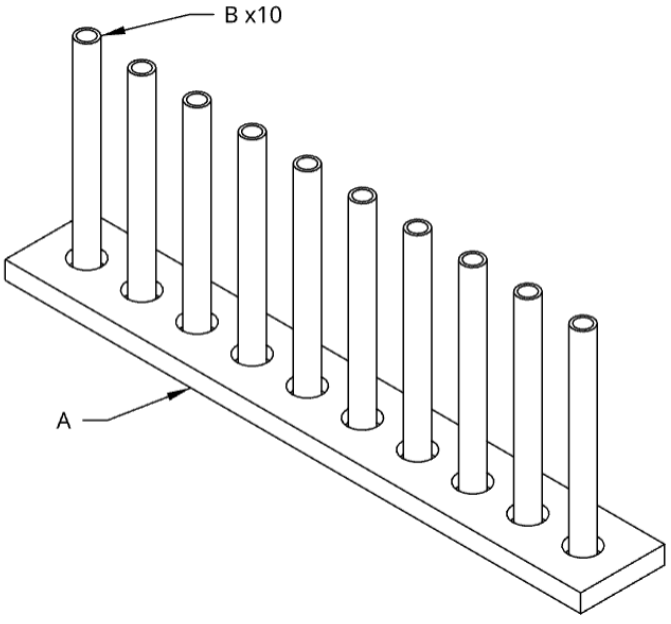
Forest Base

Made from .75” x 3.5” x 24” wood (2x4 Lumber or similar)
Note: Each circle is cut 2.30" (approximately 2 5/16") center to center from the adjacent circle.



Forest

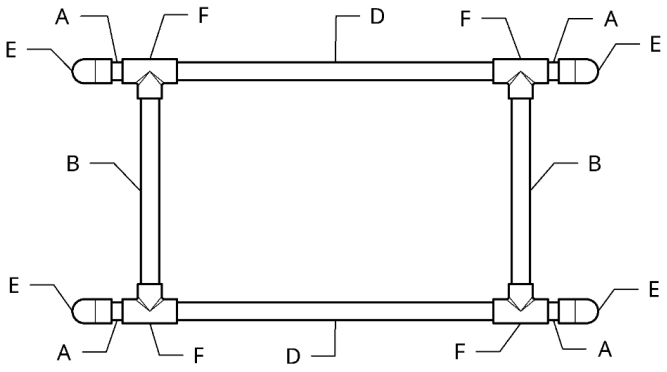
Forest Base with Trees

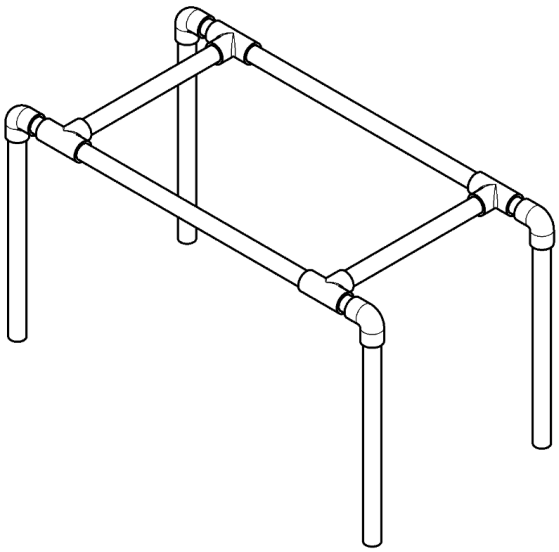


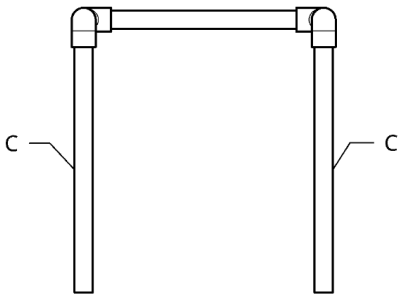
Item	Qty	Description	Size
A	1	Wood	.75” x 3.5” x 24”
B	10	1/2” SCH40 PVC Pipe	8.5” x 1”

Table Base

Made from 1/2” PVC





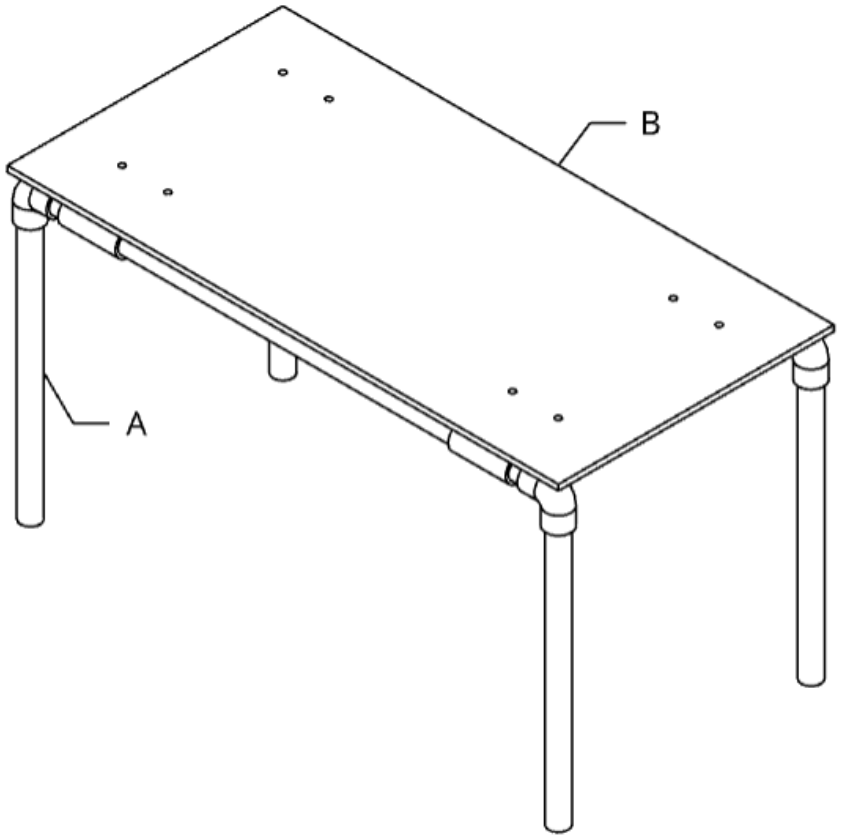


Item	Qty	Description	Size
A	4	1/2” SCH40 PVC Pipe	2” x 1/2”
B	2	1/2” SCH40 PVC Pipe	10” x 1/2”
C	4	1/2” SCH40 PVC Pipe	12” x 1/2”
D	2	1/2” SCH40 PVC Pipe	16” x 1/2”
E	4	1/2” SCH40 PVC Elbow	90°
F	4	1/2” SCH40 PVC Tee	

Table

Made from PVC Table Base, 1/4” Plywood, Zip Ties

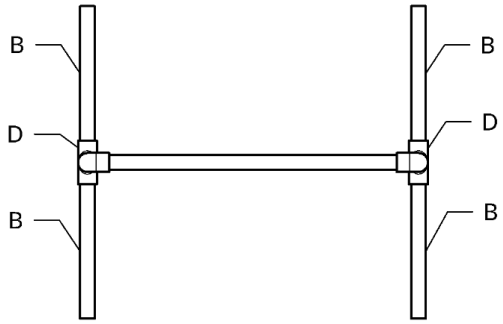
Note: Zip tie holes are approximate. Zip ties are used to hold table top to table base.
Item C is not shown in drawing. Place Zip ties through holes and tighten to PVC pipe underneath.

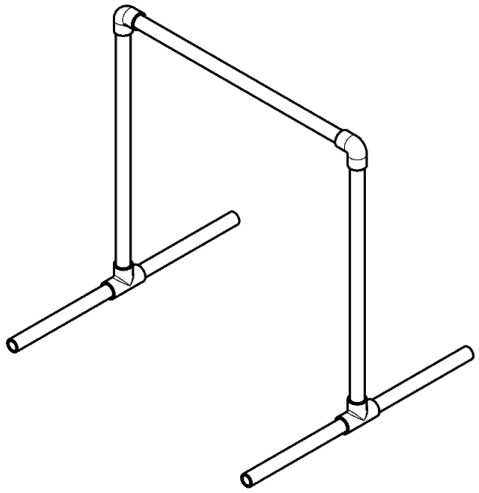


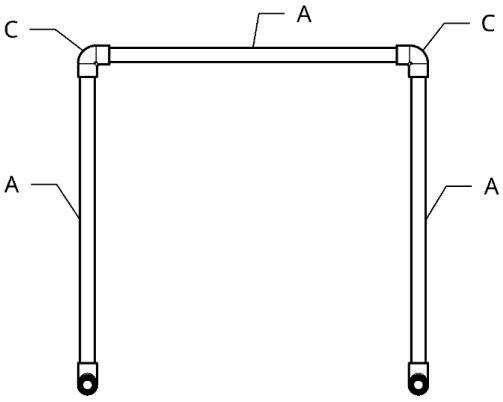
Item	Qty	Description	Size
A	1	Table Base	
B	1	1/4” Plywood Table Top	12” x 24” x 1/4”
C	4	Zip Ties	

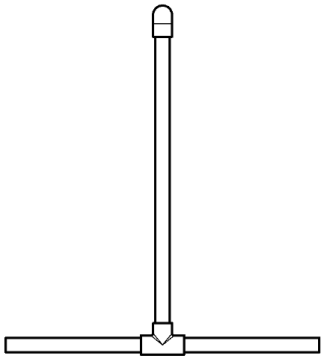
Hurdles

Two (2) hurdles will be used as one obstacle. They will be placed so that the robot must pass under them to get to the Scoring Objects. Made from ½" PVC.





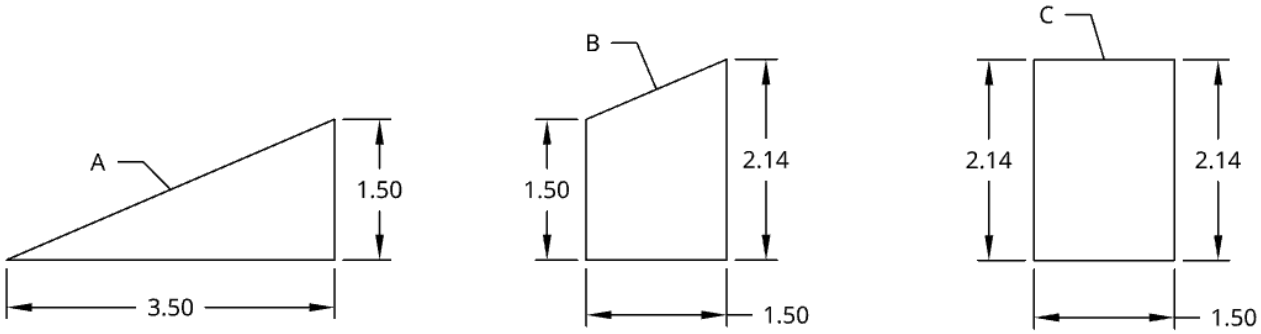


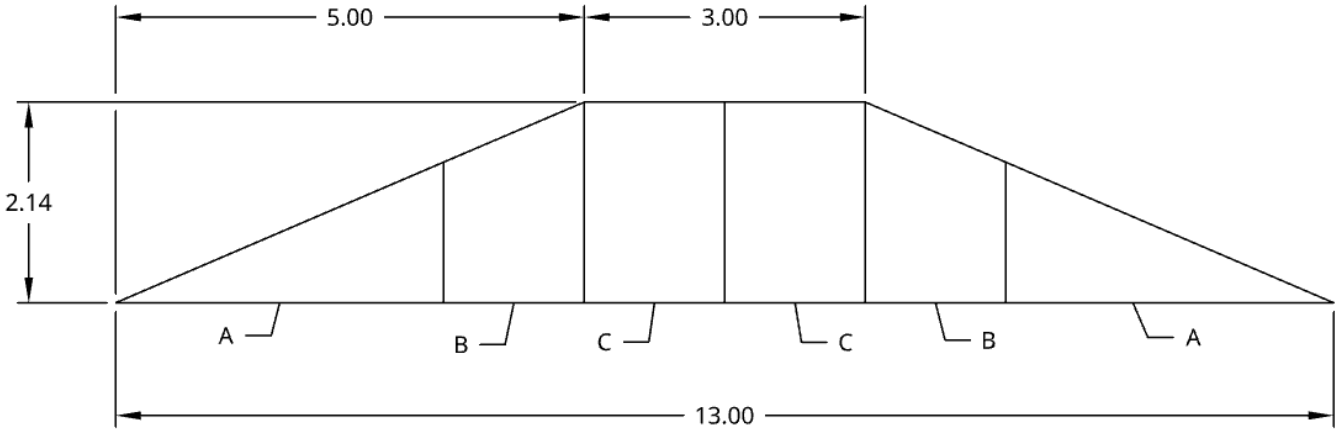


Item	Qty	Description	Size
A	6	1/2" SCH40 PVC Pipe	18" x 1/2"
B	8	1/2" SCH40 PVC Pipe	8.5" x 1/2"
C	4	1/2" SCH40 PVC Elbow	90°
D	4	1/2" SCH40 PVC Tee	

Ending Zone - Hills

Hills (for the Hills and Valley Ending Zone) may be made in one (1) piece or multiple pieces in either wood or 3d printed. The drawing below shows dimensions for making each hill out of 2x4 lumber.

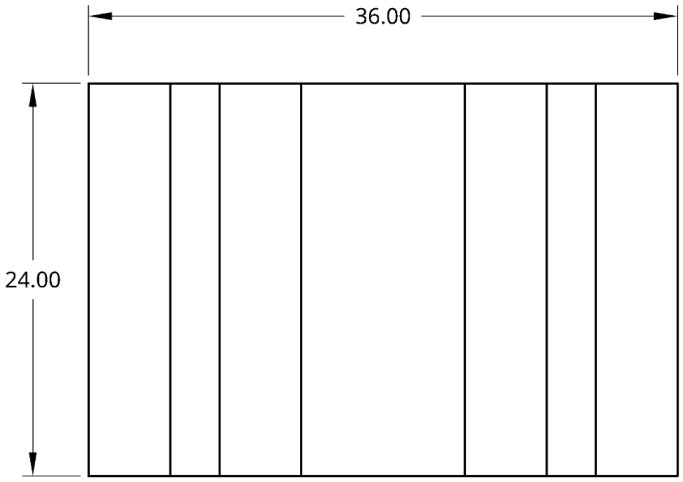


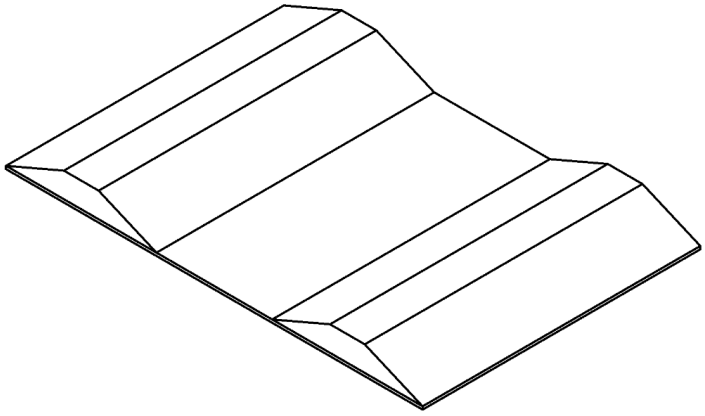


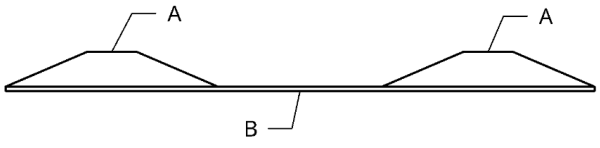
Item	Qty	Description	Size
A	4	Section A of Hills	See drawing x 24”
B	4	Section B of Hills	See drawing x 24”
C	4	Section C of Hills	See drawing x 24”

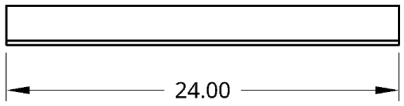
Ending Zone - Hills and Valleys

Note: Item C (not shown) are wood screws that are installed from the bottom of the plywood to attach the hills.
Wood glue may also be used.









Item	Qty	Description	Size
A	2	Hills	6.5” x 2.14” x 24”
B	1	1/4” Plywood Base	24” x 36” x 1/4“
C	~36	Wood Screws	

2027 Robotics Middle School - Scoring Sheet

Team Number and State	Run Time

Scoring Objects				
Scoring Object	**Goal**	**Scored Qty (circle)**	**Points Each**	**Total Points**
Wooden Egg	Egg Carton (Individual Slot)	0 1 2 3	X 10	
Foam Dice	6-quart storage bin (inside)	0 1 2 3	X 10	
Cones	Base Cone (stacked)	0 1 2 3	X 10	
Rings	Ring Post Stand (on vertical post)	0 1 2 3	X 10	
			Total Scoring Objects (120 Possible)	

Bonus				
Bonus Type	**Criteria**	**Earned (circle)**	**Points Each**	**Total Points**
End Zone Bonus	Robot completely inside 24" x 36" plywood (no overhang viewed from above)	0 1	X 15	
			Total Bonus (15 possible)	

Deductions				
PenaltyType	**Criteria**	**Earned (write occurenaces)**	**Points Each**	**Total Points**
Delay Penalty	Failure to start on time		X 10	
Human Interaction	Physical contact with robot on field after start		X 10	
Field Perimeter Penalty	Robot touching ground outside field perimeter		X 10	
Over-Possession	Possesion of more than one (1) object		X 5	
Obstacle Penalty	Displacing/moving an obstacle		X 5	
Obstacle Zone Boundary	Crossing PVC zone divider		X 5	
Scoring Zone Penalty	Moving Goal outside Scoring Zone		X 5	
Tree Knockdown	Trees knocked down		X 1	
			Total Deductions	

Final Score = Total Scoring Objects + Total Bonus - Total Deductions

Final Score	