

# Pool Courses – Build Guide

2023 SeaPerch Season

[www.seaperch.org](http://www.seaperch.org)

This build guide includes instructions for building the obstacle course and mission course for the *Ocean Exploration Mission* within the 2023 International SeaPerch Challenge.

Please check with your local regional coordinator for information related to which courses may be used at your local regional competition.

For the International Challenge, both courses will be suspended from the pool's lane dividers with the lower frames for the courses being approximately 5 to 5-1/2 feet below the water surface.

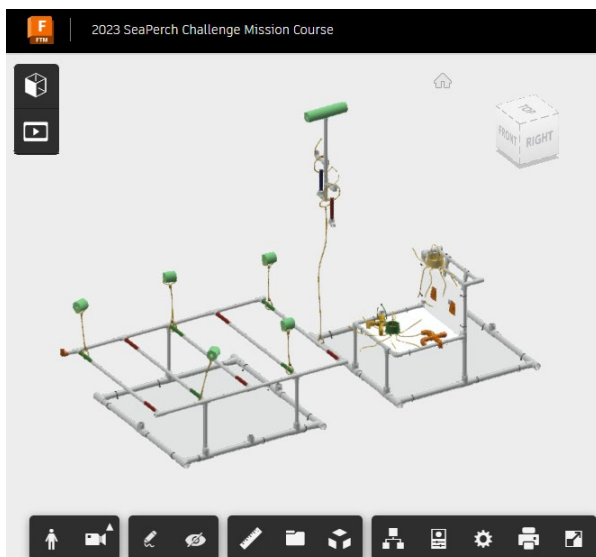
## Build Guide Contents:

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Master parts list for the 2023 International SeaPerch Challenge available at: <http://www.seaperch.org/2023-SeaPerch-Challenge-Master-Parts-List>

This parts list provides vendor links and calculates total quantities based on the number courses being built.

Full Mission Course CAD Model available at: <https://a360.co/3URpwrH> (for viewing only)



## Obstacle Course Build Guide

This obstacle course is the standard SeaPerch 5-hoop course with 4-foot spacing between the hoops. For the International SeaPerch Challenge, the hoops may be oriented differently than shown.

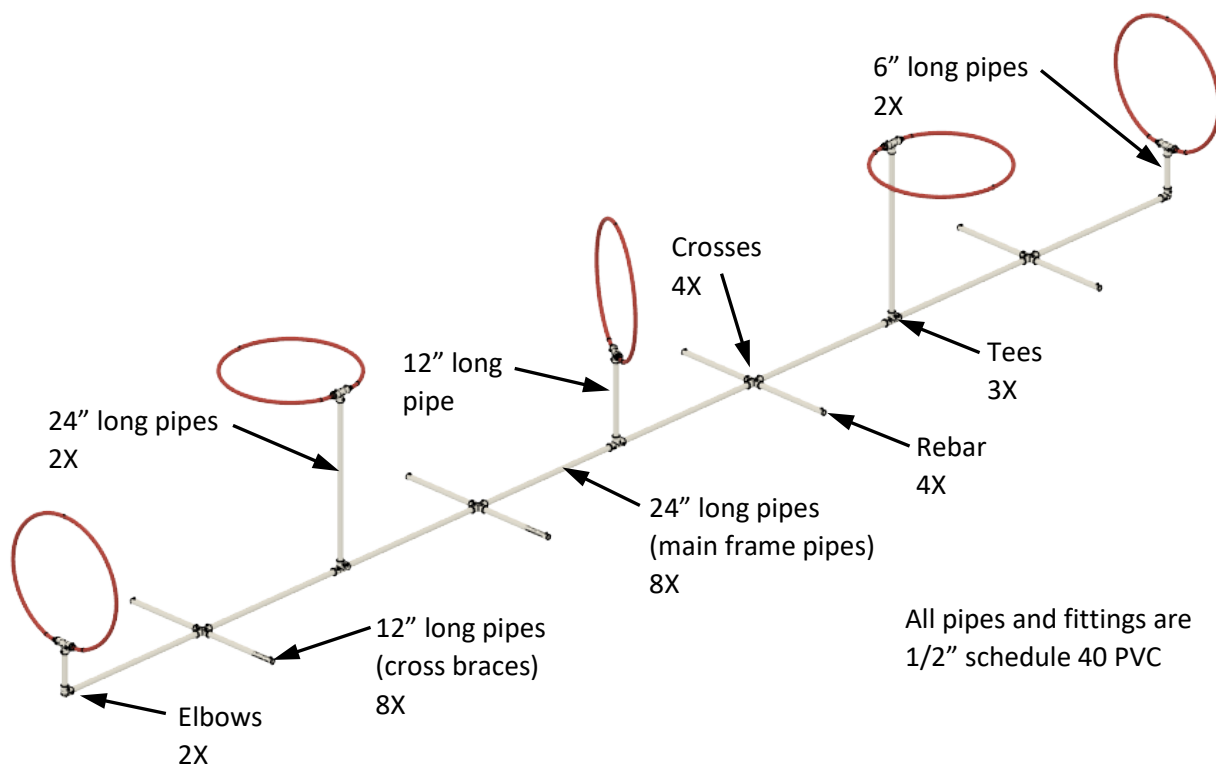
### Parts Lists

Obstacle Course Frame & Hoop Supports (5 hoops, 4-foot hoop spacing)		
Item	Unit	Qty.
1/2" Sch 40 PVC Elbow	Each	2
1/2" Sch 40 PVC Cross	Each	4
1/2" Sch 40 PVC Tee	Each	3
1/2" Sch 40 PVC Pipe X 6" Long	Each	2
1/2" Sch 40 PVC Pipe X 12" Long	Each	9
1/2" Sch 40 PVC Pipe X 24" Long	Each	10
#4 Rebar (1/2" Dia.) X 24" Long	Each	4
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	40

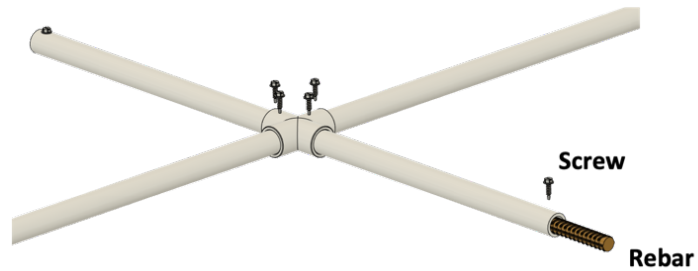
Obstacle Course Hoops (5 Hoops)		
Item	Unit	Qty.
1/2" Sch 40 PVC Tee	Each	5
1/2" Sch 40 PVC Pipe X 1" Long (if using pipe for PEX connector)	Each	10
1/2" PEX Tubing (Red) X 57" Long	Each	5
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	10
1/2" in. CPVC to PVC Bushing (alternative for PEX connection)	Each	10

**Frame and Hoop Supports:** The suggested hoop support pipe lengths (24", 12", 6") are suitable for pool depths of 4' – 7' and may need to be adjusted for pools that are shallower or deeper.

It is recommended that all pipe joints be secured with self-drilling screws from the parts list. More weight may be added to provide more stability. The total weight of the rebar is 5.4 pounds.

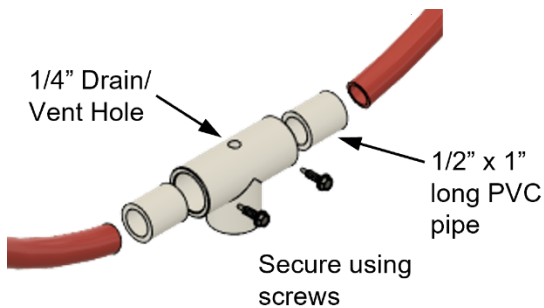


For the base of the obstacle course frame, insert rebar into the cross braces (12" long pipes). Secure the rebar with screws in the end of pipes and secure cross brace pipes to tee after inserting rebar.

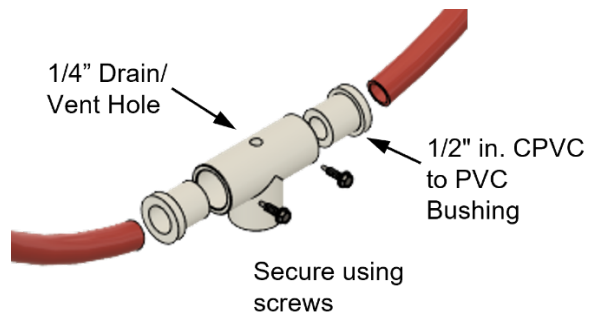


*Obstacle Course Hoops:* Assure that the PEX pipe is fully inserted into the pipes or bushing before securing with screws. Drain/vent holes (1/4") must be drilled in the hoops and pipe tees to allow air to escape when submerging and water to escape when removing from the pool.

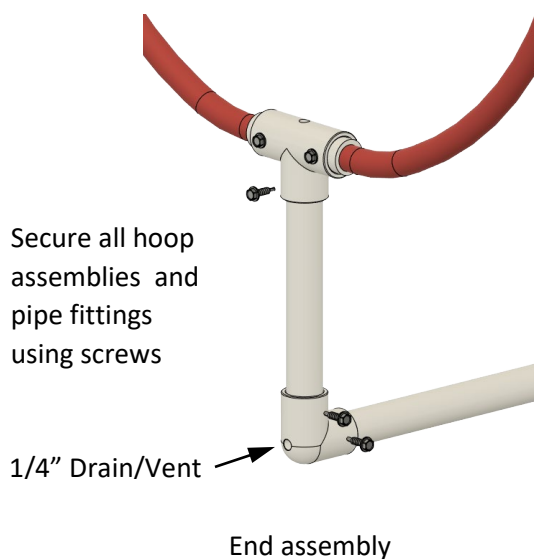
The outside diameter of the PEX pipe may be slightly larger than the inside diameter of the PVC pipe, making it extremely hard to push the PEX pipe into the PVC pipe. The 1/2" CPVC to PVC bushing provides a solution that is easier to assemble.



Traditional PEX connection method



Alternative PEX connection method

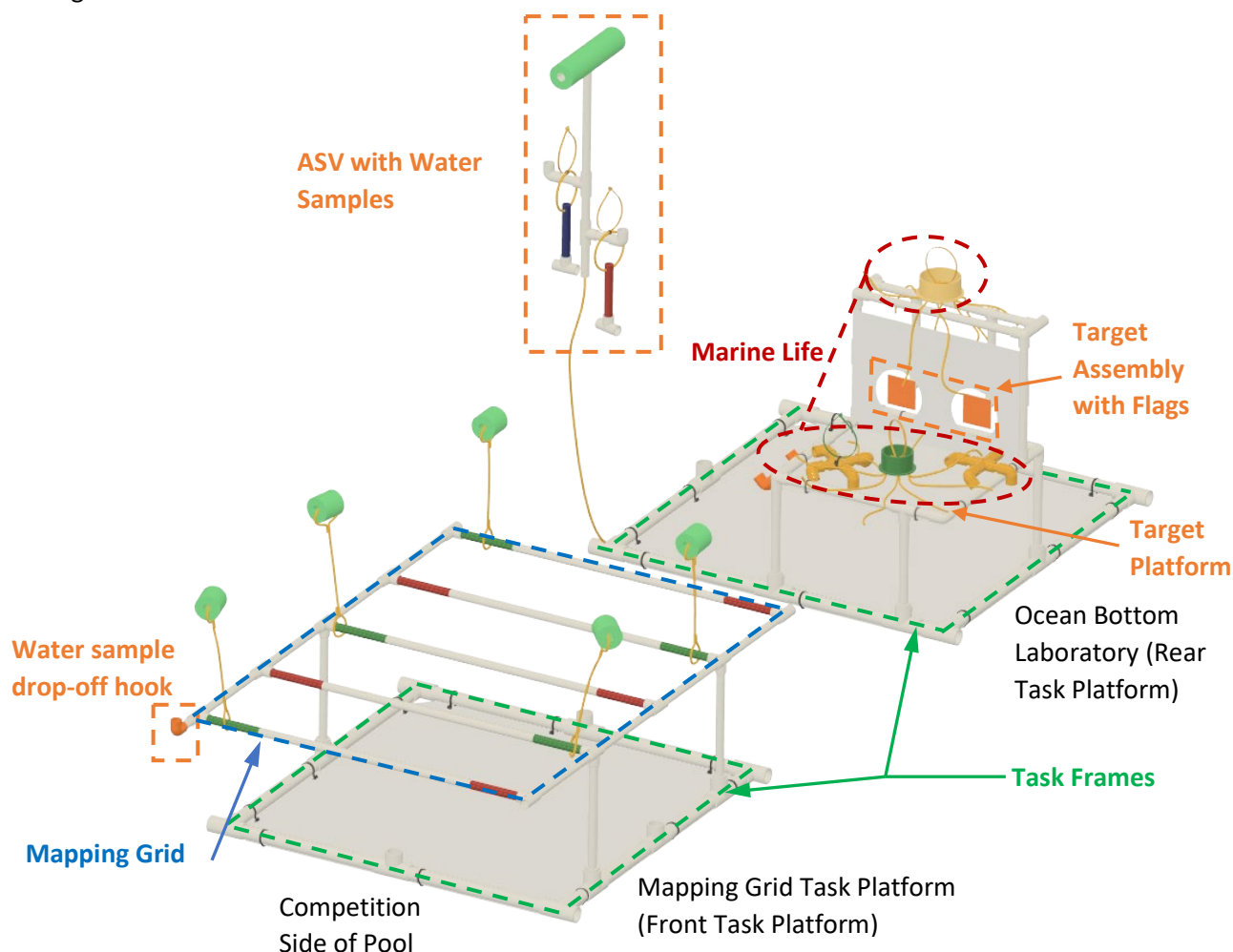


End assembly

## Mission Course Build Guide

The mission course is built upon two standard SeaPerch Challenge task frames. The frames were first used for the 2019 International SeaPerch Challenge and have been used as the foundation for the mission courses since then. The course can be constructed without the task frames if desired; however, the task frames provide a stable base and future mission courses will be built using these frames.

Some elements of the mission course are reused from previous years to help reduce the cost and effort of building the courses.



## General Construction Notes

1. It is recommended that all pipe joints be secured with self-drilling screws called out in the parts lists.
2. Pipe fittings with the potential to trap air should have drain/vent holes drilled with 1/4" or larger drill bits.
3. Pipe fitting specifications vary from one manufacturer to the next. The assembled sizes of structures could vary from the dimensions listed in this guide due to these differences. You may need to adjust the pipe lengths slightly as you construct the assemblies to ensure mating assemblies line up.
4. Anything requiring buoyancy needs to be tested and adjusted for the pool that the course will be used in.

5. Objects that must be lifted and transported have been weighed in air and in water. Weights listed may vary slightly in the pool that the course will be used in since the water density in the test pool may be different.
6. The task platforms can be weighted down using rebar; however, 6' of 1/2" diameter rebar only weighs 4 lbs. and 6 feet of 5/8" rebar only weighs 6.2 lbs. The 5/8" rebar is usually only available in 10-foot or 20-foot lengths so it will need to be cut.
7. Two 10 lb. rubber coated dumbbells were used in testing and provided ample weight to keep the platforms from moving.

### Task Frames (Task Platforms)

These mission task frames were used from 2019 to 2022. If you built these frames according to the directions provided, no modifications are necessary; however, the frame can optionally be modified to use standard tees instead of snap-on saddle tees. The 1" snap-on saddle tees are only available online and are more expensive than standard tees. See the instructions below.

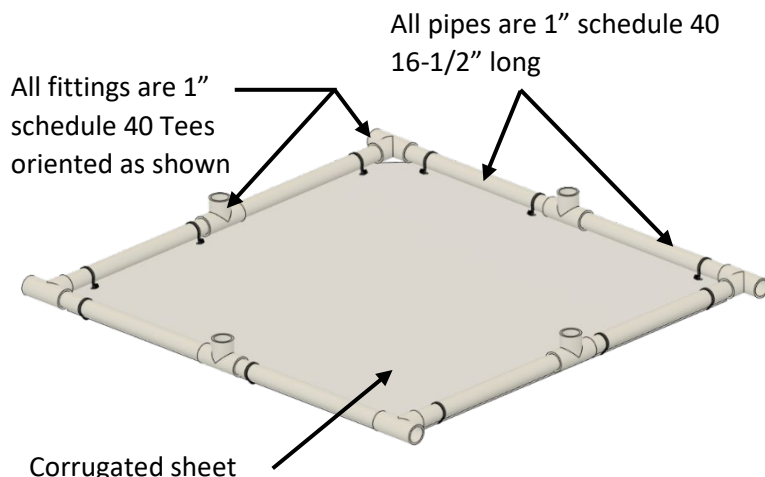
The polypropylene plate is optional for courses used on the pool floor. Use cable ties to secure the polypropylene plate to the frame.

If the courses are being used on the pool floor, rebar or other weights should be used. See item 6 and 7 in the *General Construction Notes* section above.

Task Frame (Quantities are for 2 frames)		
Item	Unit	Qty.
1" Sch 40 PVC Tee (DURA brand – may use other brands, but see item 3 in the <i>General Construction Notes</i> section above)	Each	16
1" Sch 40 PVC Pipe X 16.5" Long	Each	16
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	32
Polypropylene Corrugated Sheet, .157 Thick, 36" X 36" (Optional for pool floor course)	Each	2
8" Cable Tie (Only needed if using Polypropylene sheet)	Each	24
Weights (see item 6 and 7 in the <i>General Construction Notes</i> section above)		

Construct the two task frames as shown.

Notch the corners of the corrugated sheet as needed. Attach the corrugated sheet to the frame using 8" cable ties.



## Optional construction method to eliminate the 1" snap-on saddle tees used on the mapping grid and target platform.

Optional construction of mapping grid task frame.

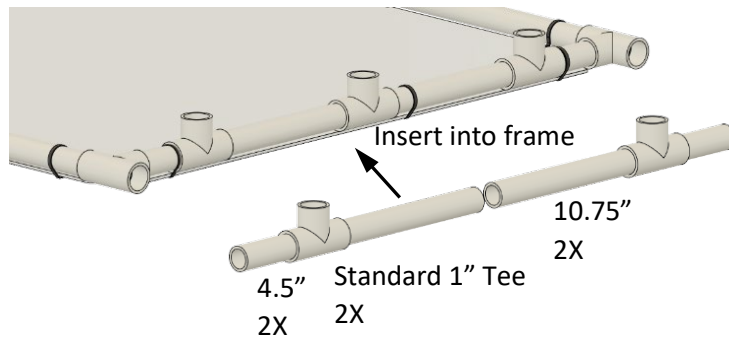
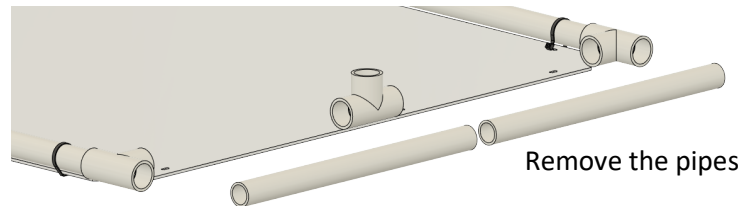
Cut the cable ties from the pipes that will be removed.

Remove the two existing pipes as shown.

Cut the pipes into the lengths shown.

Insert the pipes in the tees and insert the new assembly into the frame.

Replace the cable ties.



Optional construction of Ocean Laboratory task frame.

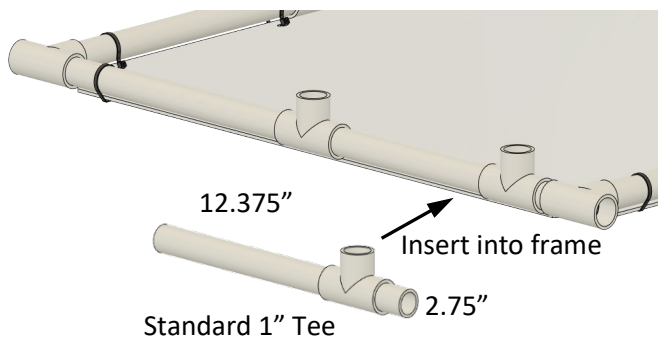
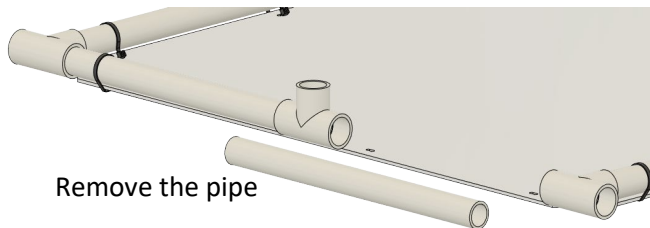
Cut the cable ties from the pipes that will be removed.

Remove the two existing pipes as shown.

Cut the pipes into the lengths shown.

Insert the pipes in the tees and insert the new assembly into the frame.

Replace the cable ties.

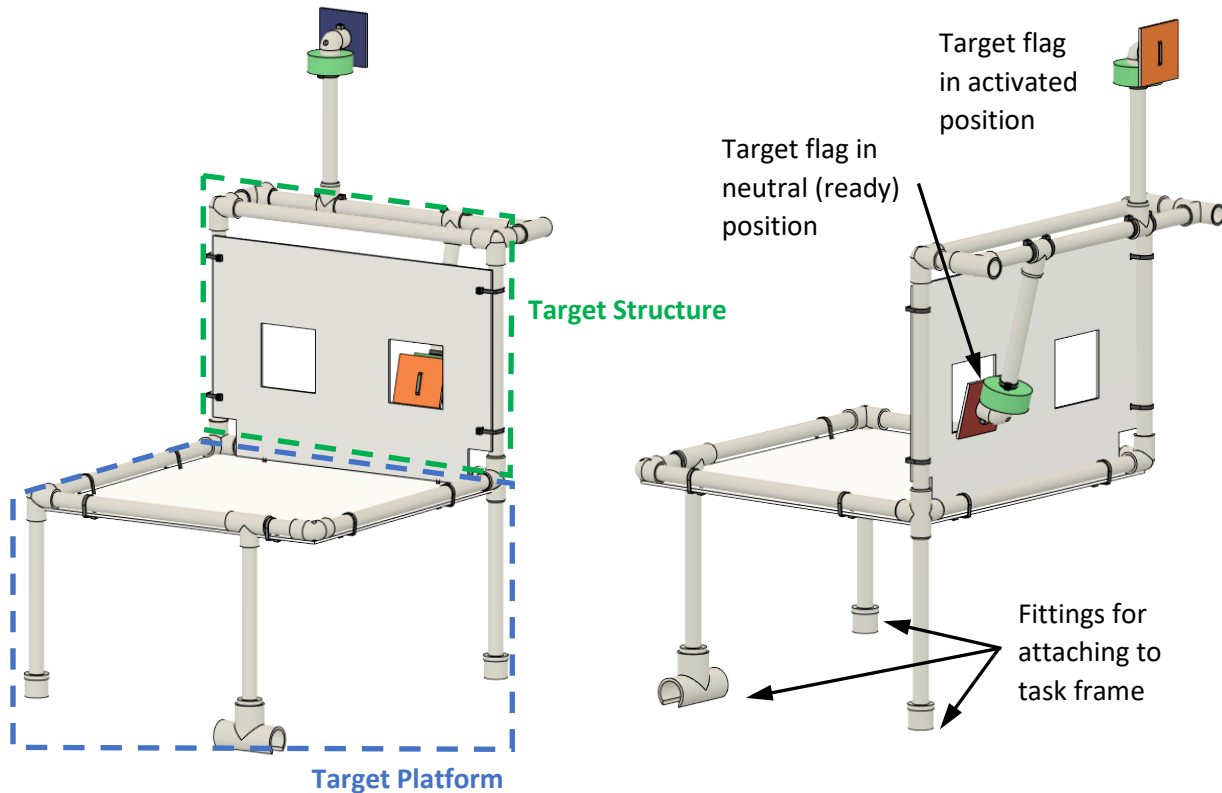


## Ocean Bottom Laboratory

The ocean bottom laboratory consists of the rear task platform with the target platform and target structure.

The target platform is the Battery Pallet platform from the 2022 mission course. There are a couple of modifications needed to adapt it for the 2023 mission course. If you already have this structure, then follow the modification instructions and skip following construction details.

### Target structure and target platform



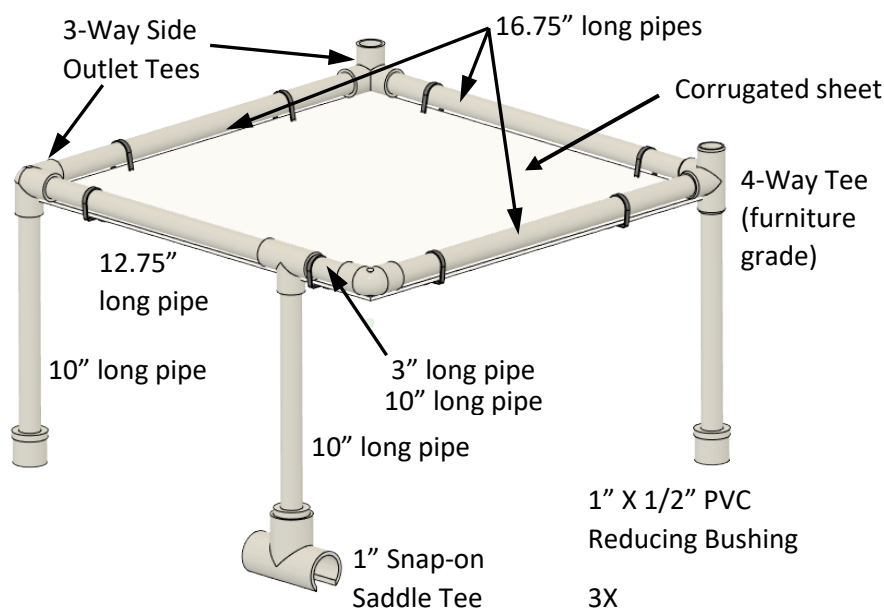
**Target platform construction** (build if you do not have the Battery Pallet from the 2022 SeaPerch Challenge).

Target Platform Parts List		
Item	Unit	Qty.
1/2" Sch 40 PVC Elbow	Each	1
1/2" Sch 40 PVC 3-Way Side Outlet Elbow (standard plumbing grade or furniture grade)	Each	2
1/2" 4-Way Tee (furniture grade)	Each	1
1/2" Sch 40 PVC Tee	Each	1
1" X 1/2" Sch 40 Reducing Bushing	Each	3
1" PVC Snap-On Saddle Tee (see note below)	Each	1
1/2" Sch 40 PVC Pipe X 3" Long	Each	1
1/2" Sch 40 PVC Pipe X 10" Long	Each	3
1/2" Sch 40 PVC Pipe X 12.75" Long	Each	1
1/2" Sch 40 PVC Pipe X 16.75" Long	Each	3
Polypropylene Corrugated Sheet, .157 Thick, 18" X 18"	Each	1
8" Long Cable Ties (may be substituted with other sizes)	Each	8
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	18

Construct the target platform as shown.

Notch the corners of the corrugated sheet as needed. Attach the corrugated sheet to the frame using 8" cable ties.

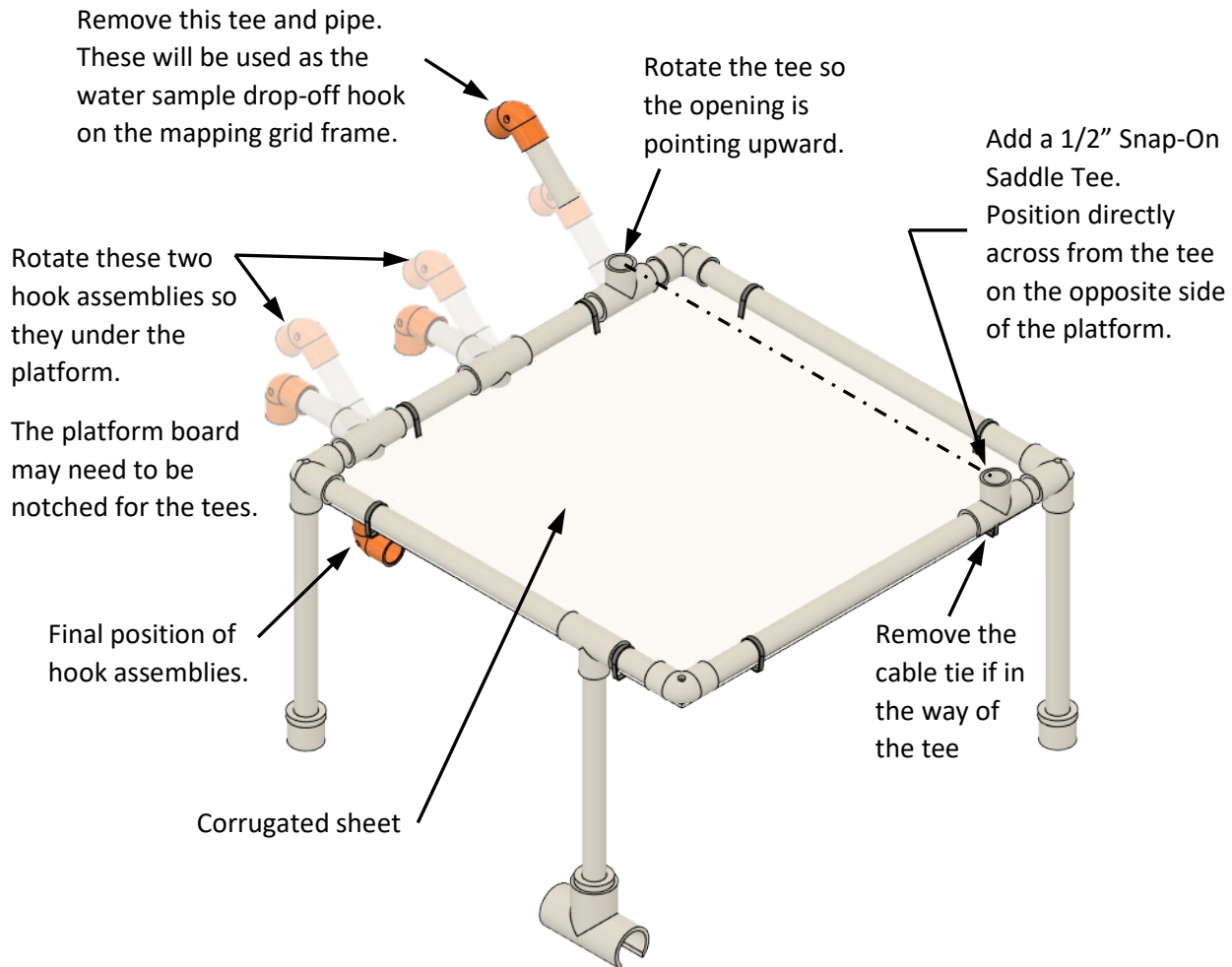
You do not need the snap-on saddle tees if you modified the task frames per the optional construction method on page 6.





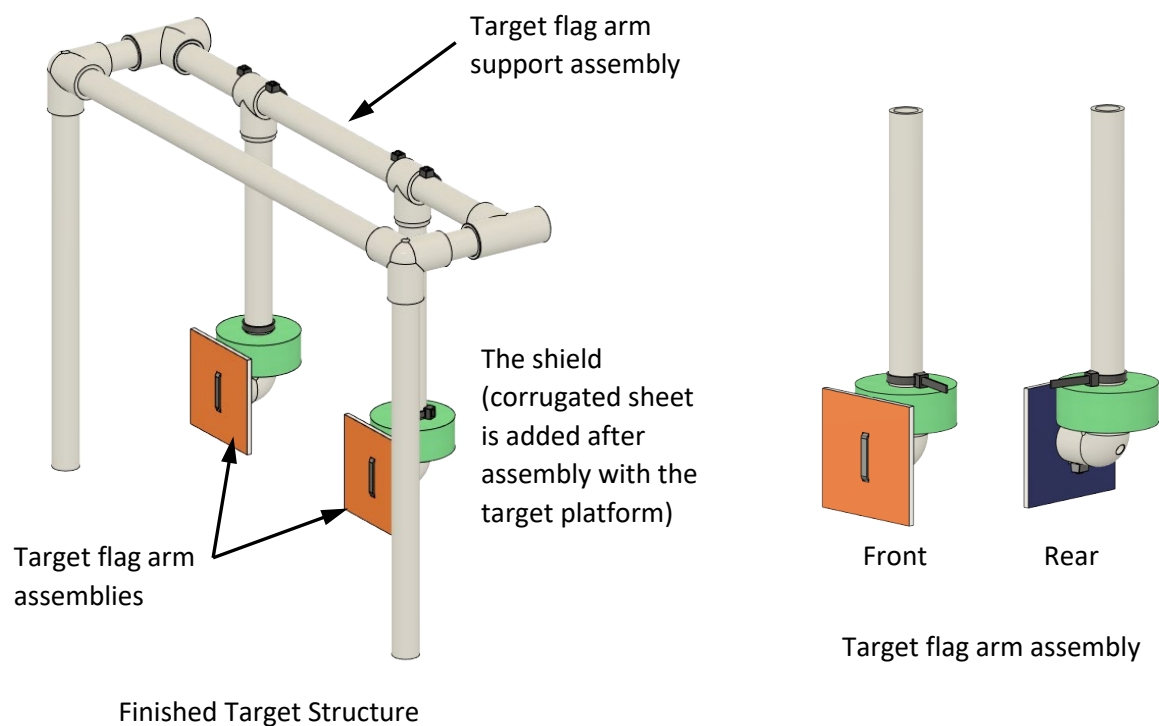
## 2022 Battery Pallet Conversion

For regional coordinators and teams that built the 2022 mission course and have the 2022 Battery Pallet, modify the 2022 battery pallet as shown to prepare it for the target frame.



## Target Structure Construction

Target Structure Parts List		
Item	Unit	Qty.
1/2" Sch 40 PVC Elbow	Each	2
1/2" Sch 40 PVC Tee	Each	2
1/2" Sch 40 PVC 3-Way Side Outlet Elbow (standard plumbing grade or furniture grade)	Each	2
1/2" PVC Furniture Grade Sling Tee	Each	2
1/2" Sch 40 PVC Pipe X 2.5" Long	Each	2
1/2" Sch 40 PVC Pipe X 8" Long	Each	2
1/2" Sch 40 PVC Pipe X 12" Long	Each	2
1/2" Sch 40 PVC Pipe X 16.75" Long	Each	2
2.5" Diameter x 1" Long Pool Noodle (length may need to be adjusted to achieve desired buoyancy)	Each	2
Polypropylene Corrugated Sheet, .157 Thick, 3" X 3"	Each	2
Polypropylene Corrugated Sheet, .157 Thick, 12" X 18"	Each	1
8" Long Cable Ties (may be substituted with other sizes)	Each	12
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	14
Colored Duct Tape: orange, red, and blue		



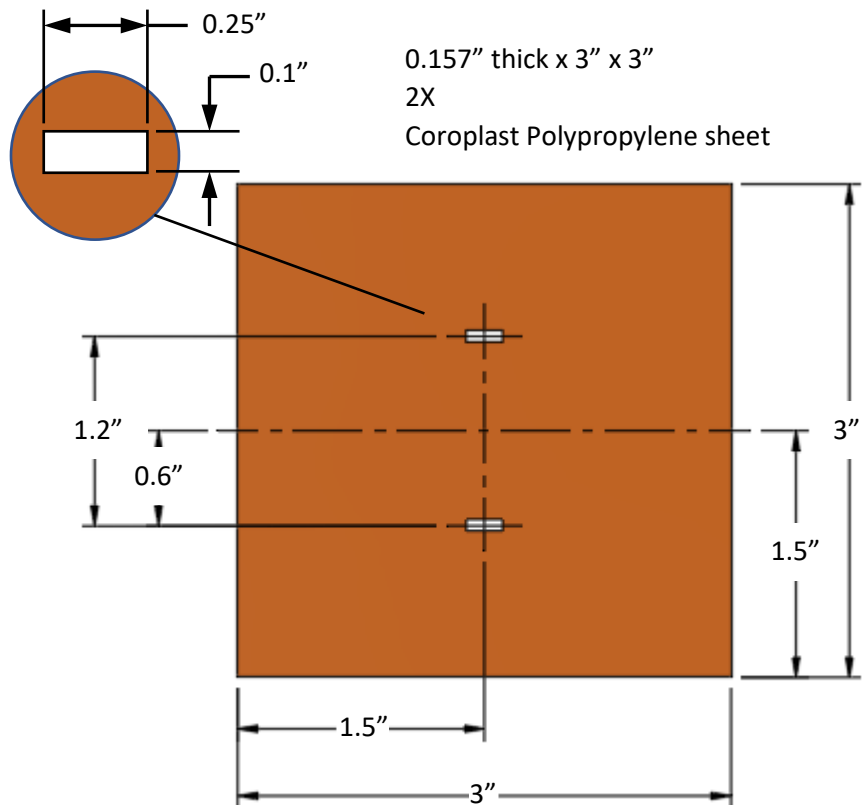
Construct 2 target flags as shown.

The rectangular hole sizes and hole spacing dimensions are not critical. The holes just need to be large enough for the cable tie to pass through. The hole spacing just needs to be wider than the outside diameter of the elbow.

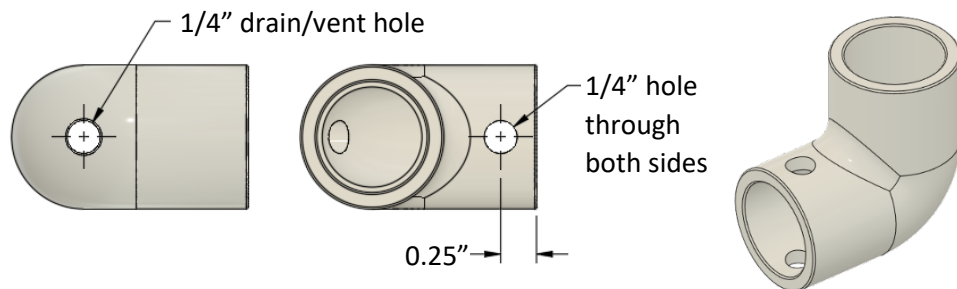
A flat blade screwdriver works well to create the hole.

Color the front of both target flags orange. Color the back of one flag blue and the back of the other flag red.

Colored duct tape works well, but waterproof paint may also be used.

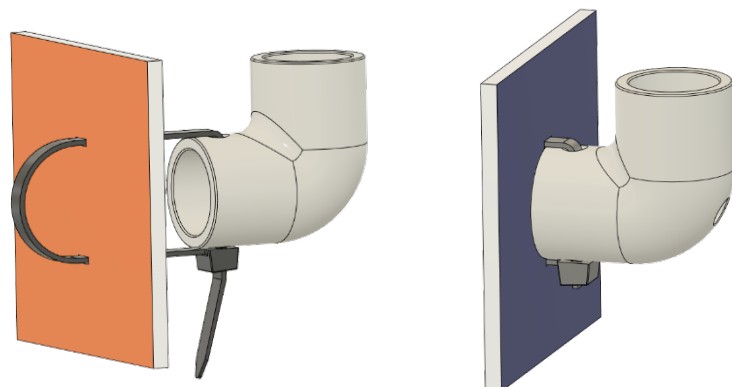


Drill holes in two 1/2" schedule 40 elbows as shown.



Attach the target flags to the elbows using an 8" cable tie as shown.

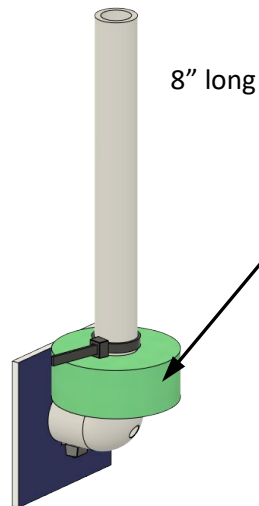
Pull cable tie tight and cut excess end.



Assemble the two target flag arm assemblies as shown.

Insert the 8" long pipe into the elbow that is attached to the flag.

Slide the float over end of elbow as far as it will press onto the elbow.

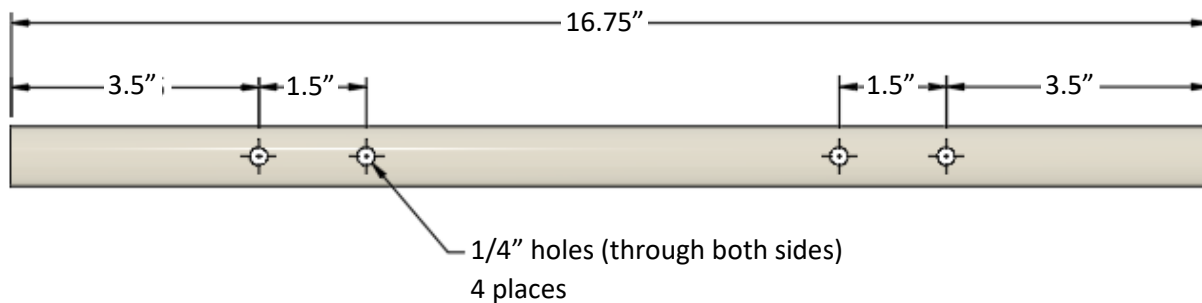


8" long pipe

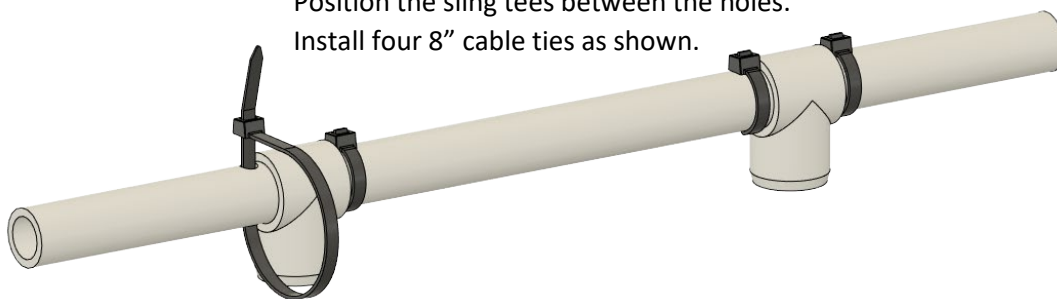
Install a cable tie around the pipe. Leave the cable tie loose until the buoyancy has been properly adjusted during in-pool testing and the target flag activates as desired.

Trim the excess cable tie end, leaving approximately 1" sticking out of the cable tie locking end.

The sling tees on the frame need to be locked in place to prevent them from sliding along the pipe while still being allowed to rotate freely. There are several ways to accomplish this. One way is to put screws beside the sling tees or use cable ties around the pipe without drilling holes. The following design was chosen because it provides a positive lock and will not bind the sling tees.

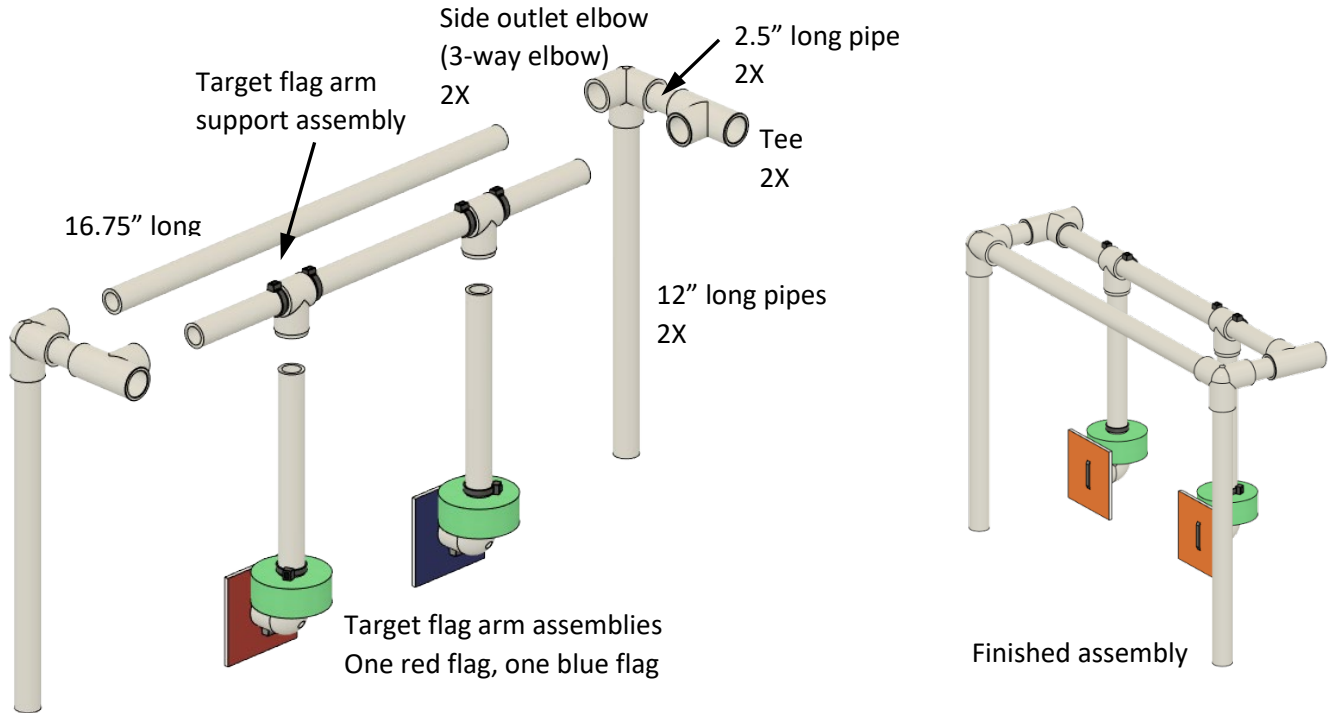


Position the sling tees between the holes. Install four 8" cable ties as shown.

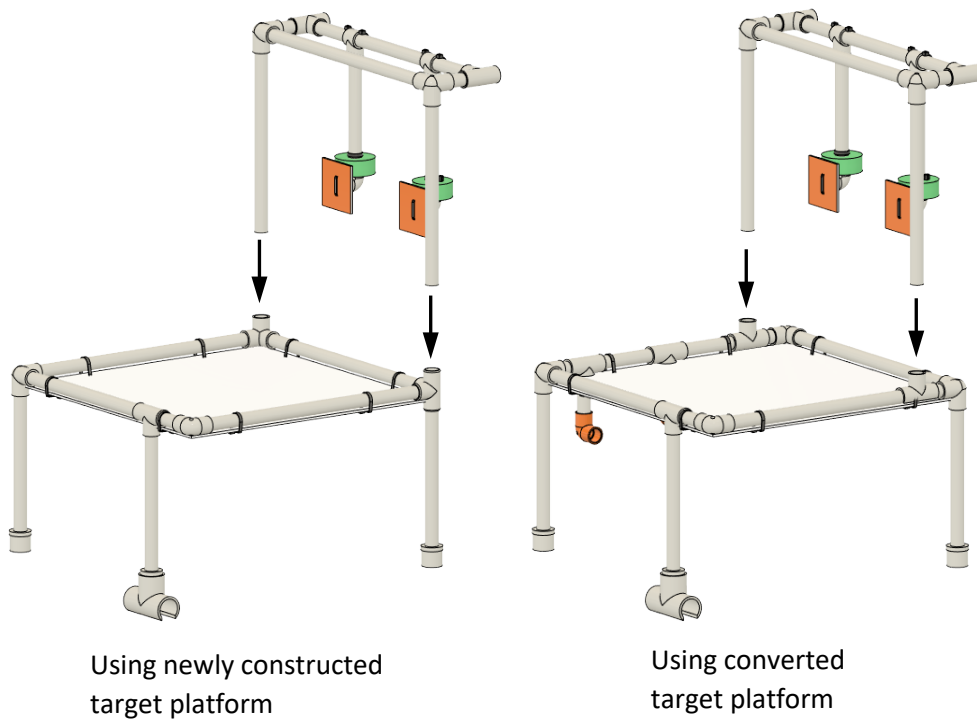


Target flag arm support assembly

Assemble the target structure as shown.



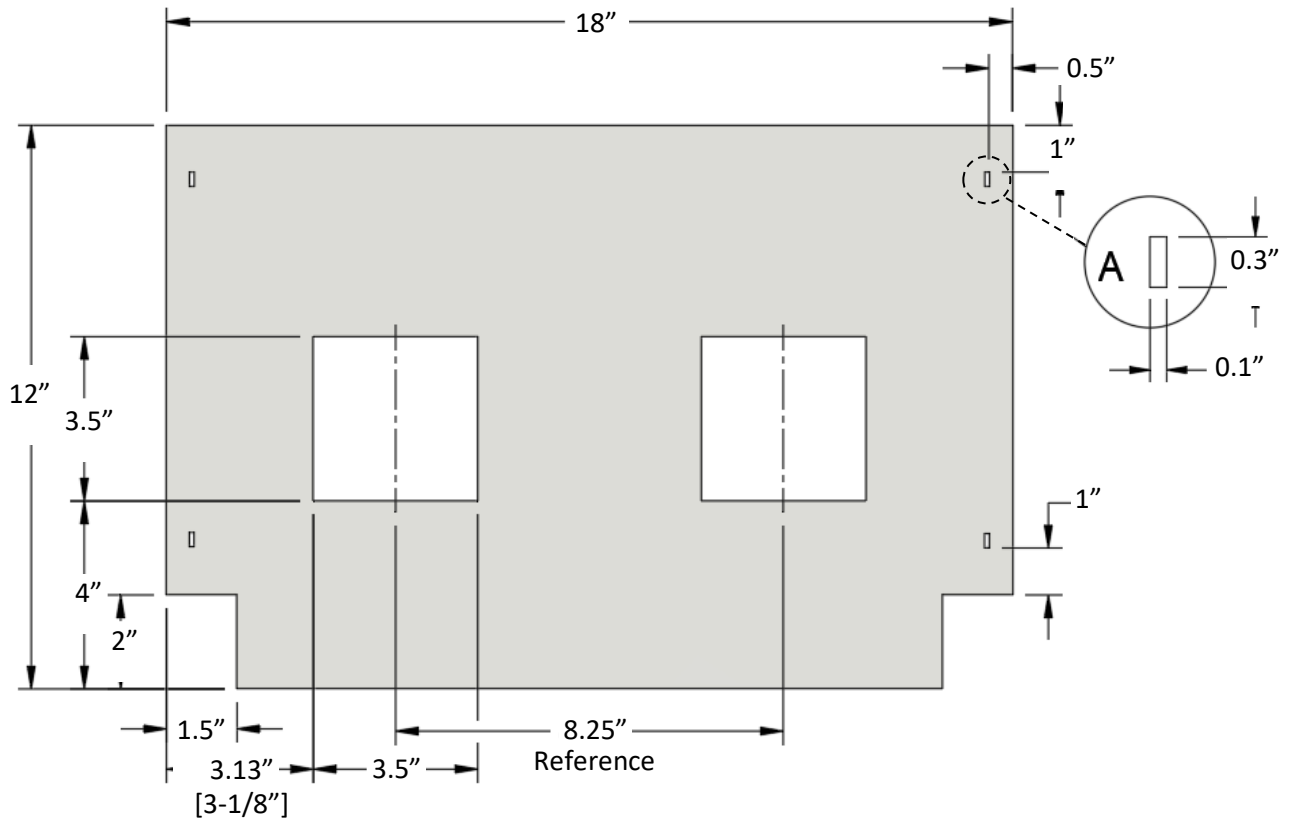
Mount the target structure on the target platform



### Construct and Mount the Target Shield

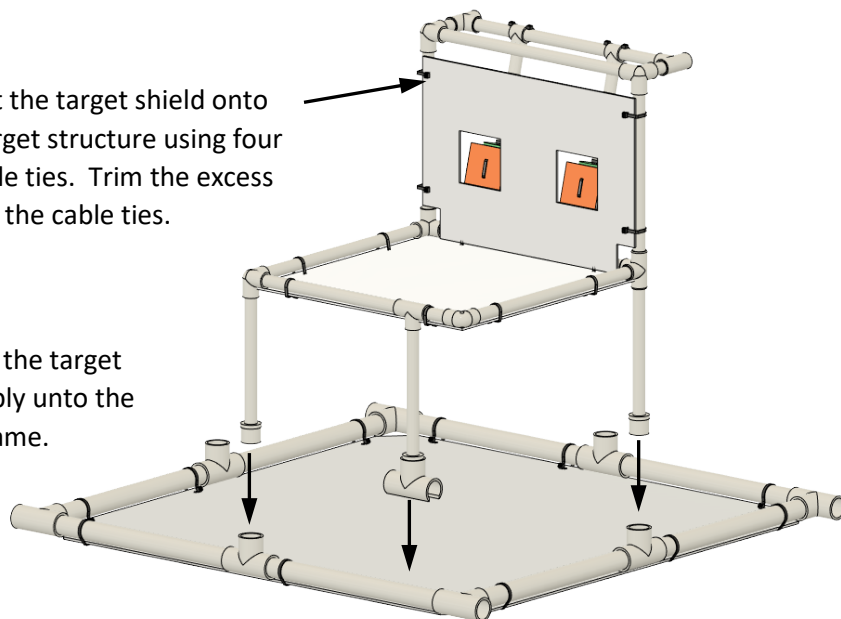
Cut the target shield from 0.157" thick polypropylene corrugated sheet.

The small rectangular slots are not critical. The slots just need to be large enough for the cable tie to pass through. A flat blade screwdriver works well to create the slots.



Mount the target shield onto the target structure using four 8" cable ties. Trim the excess end of the cable ties.

Mount the target assembly onto the task frame.



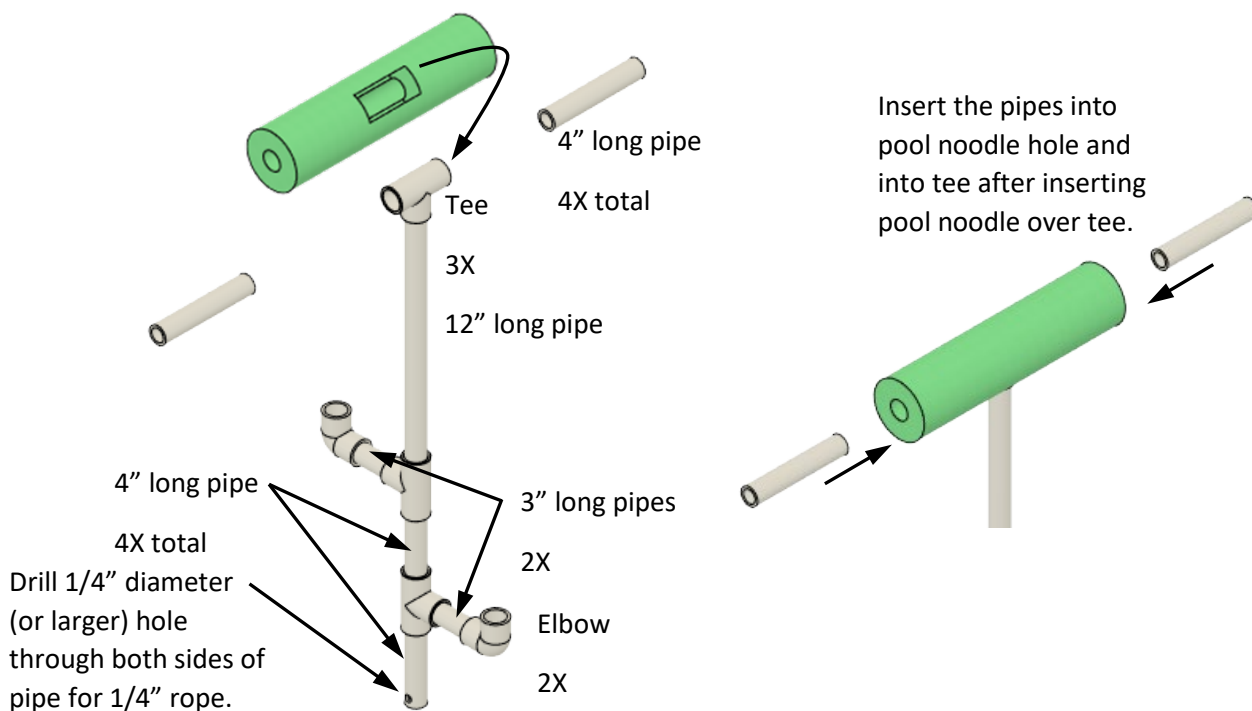
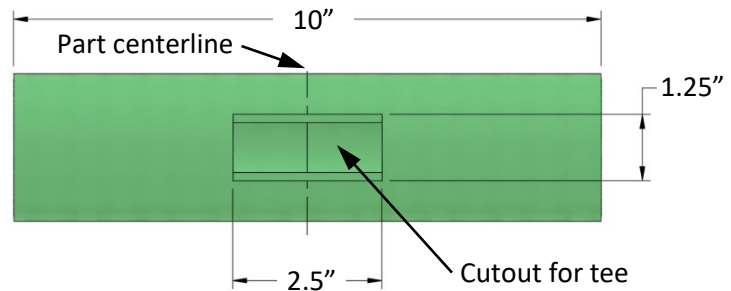
## Autonomous Surface Vehicle (ASV) Construction

ASV Parts List		
Item	Unit	Qty.
1/2" Sch 40 PVC Elbow	Each	2
1/2" Sch 40 PVC Tee	Each	3
1/2" Sch 40 PVC Pipe X 3" Long	Each	2
1/2" Sch 40 PVC Pipe X 4" Long	Each	4
1/2" Sch 40 PVC Pipe X 12" Long	Each	1
2.5" Diameter x 10" Long Pool Noodle	Each	1
1/4" Polypropylene Rope, length determined by pool depth	Each	1
8" Long Cable Ties ( <i>may be substituted with other sizes</i> )	Each	2
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw (optional if pipes fit tightly into pipe fittings)	Each	9

Cut an opening for the pipe tee in the pool noodle.

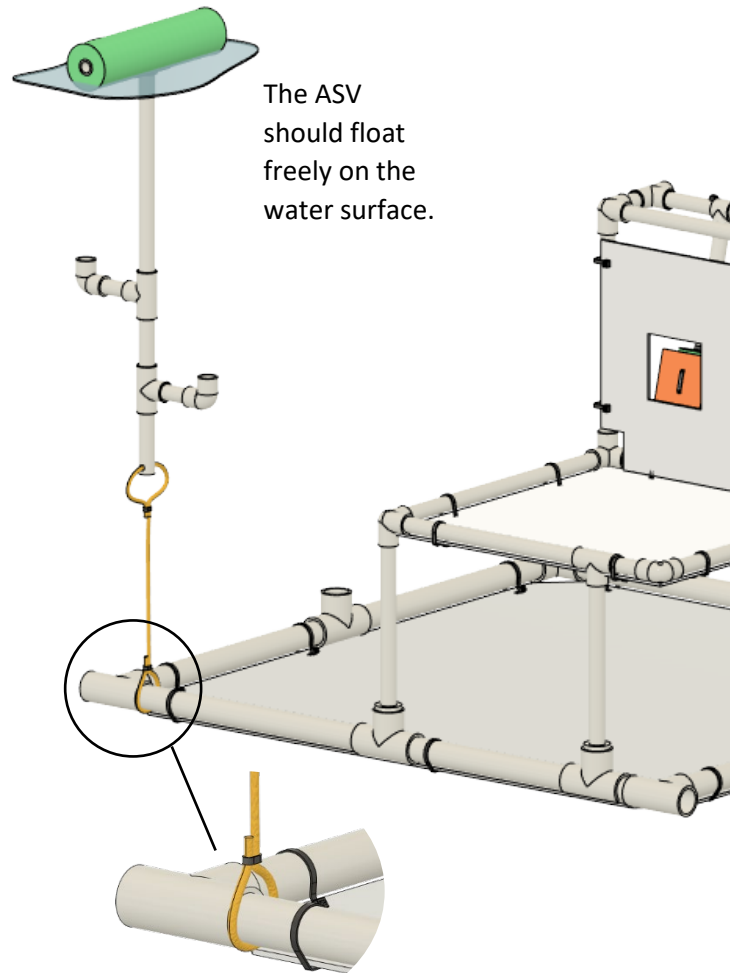
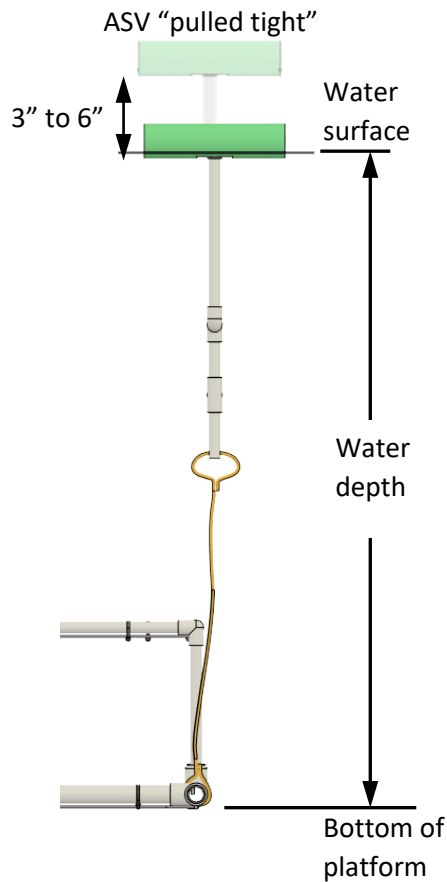
Dimensions are not critical. You just need to be able to insert the tee into the opening.

Assemble the ASV as shown.



## Attach the ASV to the Task Frame

Loop one end of the rope around the corner of the task frame and fasten the end of the rope using a cable tie. To determine the length of the rope, hold the ASV with the float being a distance equal to the water depth plus 3" to 6" from the bottom of the task frame. Tie a loop through the hole in the lower pipe of the ASV. This provides some slack in the rope with the ASV floating on the water surface.





## Water Sample Containers

The water sample containers are constructed from the Tools used in the 2022 SeaPerch Challenge.

If you already have the Tools:

1. You only need the additional cable tie (optional).
2. Remove the foam rods that were used to make the tools neutrally buoyant.
3. Add the 14" cable ties to the rope loops.

Water Sample Containers Parts List		
Item	Unit	Qty.
1/2" Sch 40 PVC Tee	Each	2
1/2" Sch 40 PVC Pipe X 6" Long	Each	2
1/4" Polypropylene Rope x 12" Long	Each	2
4" Cable Tie	Each	4
14" High Visibility Cable Tie	Each	2
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw (optional if pipes fit tightly into pipe fittings)	Each	2
Options for coloring pipes: use colored PVC pipe, colored duct tape, or waterproof paint		

Maximum weights of each water sample container:

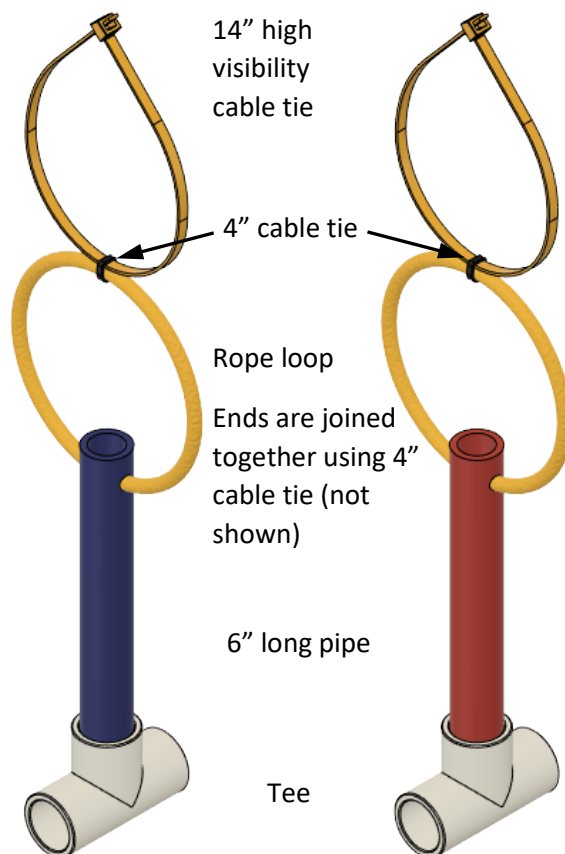
In air = 80 grams

In water = 19 grams

The pipe of each water sample container should be painted or taped, one red and one blue. Pipes used for the International Challenge are colored PVC pipes.

Screws are not required for the pipe joints unless the pipe fits loose in the fittings.

The 14" cable ties are used to make it easier to remove the water sample containers from the ASV.



## Marine Life Construction

### Sea Stars

Sea Star Parts List (for two Sea Stars)		
Item	Unit	Qty.
1/2" Sch 40 PVC Elbow	Each	8
1/2" Sch 40 PVC Cross	Each	2
1/2" Sch 40 PVC Pipe X 2" Long	Each	8
8" Cable Tie	Each	1
14" Cable Tie (can connect two 8" cable ties to create the loop)	Each	1

Maximum weights of each sea star:

In air = 173 grams

In water = 50 grams

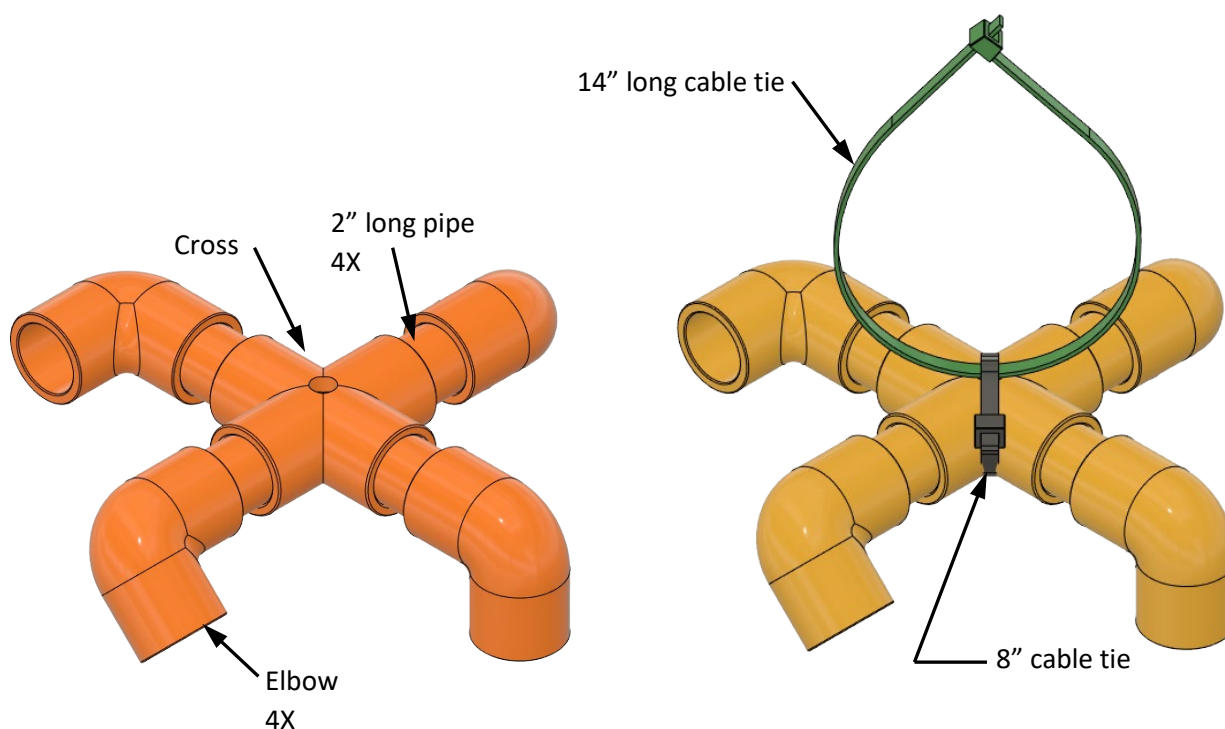
Assemble the Sea Stars as shown.

Painting is optional.

Screws are not required for the pipe joints unless the pipe fits loose in the fittings.

The elbows may be oriented differently than shown for the International Challenge.

Only one sea star will have a cable tie loop for the International Challenge. The sea star without the cable tie will be more challenging to lift and transport.



## Octopuses

Octopuses Parts List		
Item	Unit	Qty.
3" PVC Snap-In Drain (for small octopus)	Each	1
4" PVC Snap-In Drain (for large octopus)	Each	1
3/16" Polypropylene Diamond Braid Rope, 18" long (for small octopus)	Each	4
3/16" Polypropylene Diamond Braid Rope, 24" long (for large octopus)	Each	4
4" Cable Ties	Each	8
8" Cable Ties	Each	2
14" High Visibility Cable Ties (can use 1/4" Polypropylene rope instead)	Each	2
5/8" Diameter x 3" Long Poly Foam Backer Rod	Each	2
1/4" Bolt Size x 1.5" Outside Diameter x 0.55" Thick Stainless Steel Fender Washer (these are the washers used in the 2019 and 2021 mission course canisters) (can substitute with other materials and other sizes)	Each	8

Maximum weights of small octopus:

In air = 148 grams

In water = 50 grams

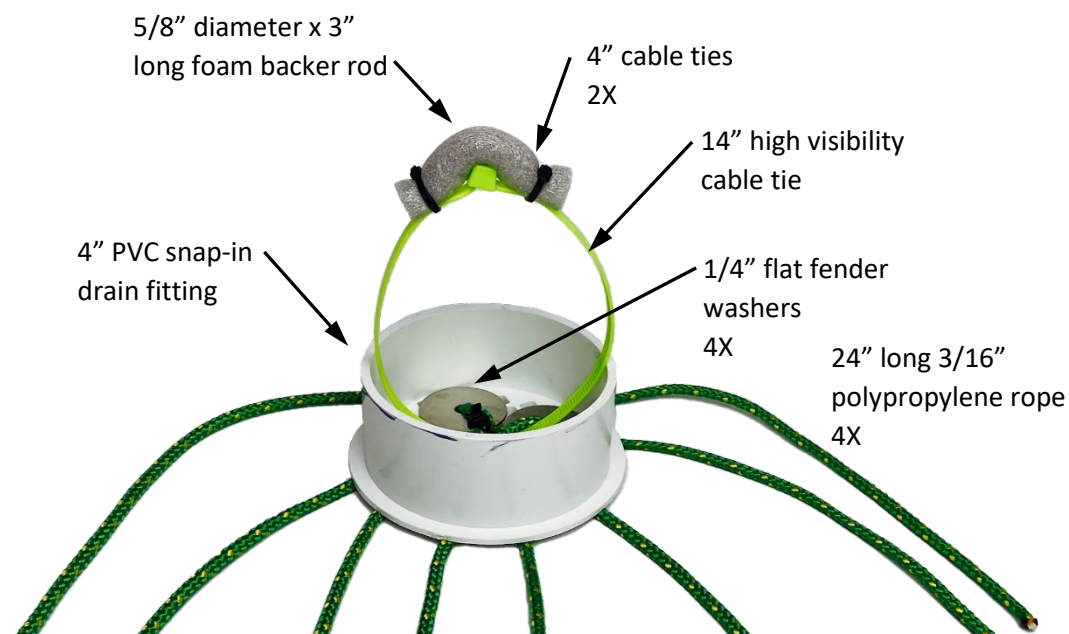
Maximum weights of large octopus:

In air = 185 grams

In water = 63 grams

The polypropylene diamond braid rope can be substituted with pipe cleaners or other pool tested materials. Material that is lightweight or flexible can get tangled in the ROV thrusters.

*Construct the large octopus.*

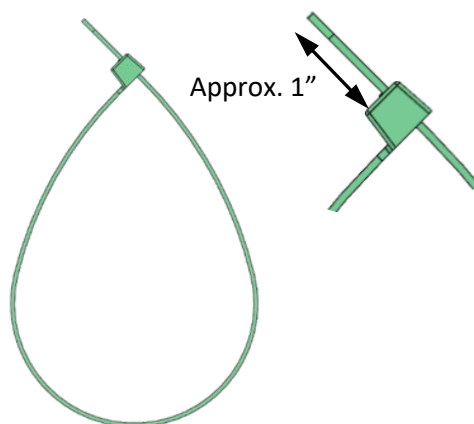


Cut four 24" pieces of the 3/16" diameter rope. Carefully melt the ends using a lighter, matches, or other source to keep the ends from fraying. *Use safety precautions when melting the ends of the ropes.*

Connect the end of the 14" cable tie and leave approximately 1" of the free end sticking out of the lock. Trim the excess end.

Set 4 washers in the inside the drain fitting.

Hold the 14" cable with the round part of the loop in the drain fitting over the washers.



Feed the ends of a piece of rope over the 14" cable tie and through the holes in two of the washers and through the drain fitting.

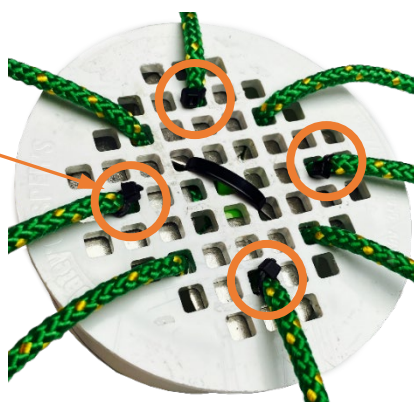
Feed the ends of a piece of rope over the 14" cable tie and through the holes in the remaining two washers and through the drain fitting.

Feed the ends of the remaining two ropes over the 14" cable tie and through holes in the drain fitting. The ropes should line up between the outer intersecting edges of the flat washers.



Attach an 8" cable tie over the bundle of ropes and through holes in the drain fitting (as highlighted by the orange ellipse). Pull the cable tie tight to secure the ropes and the 14" cable tie. Cut the excess end of the cable tie.

Attach four 4" cable ties on the ropes that pass through the washers.



Foam rod is used to reduce the in-water weight of the octopus and to help it stay upright.

Attach the 3" long piece of 5/8" diameter foam to the 14" cable tie using two 4" cable ties.



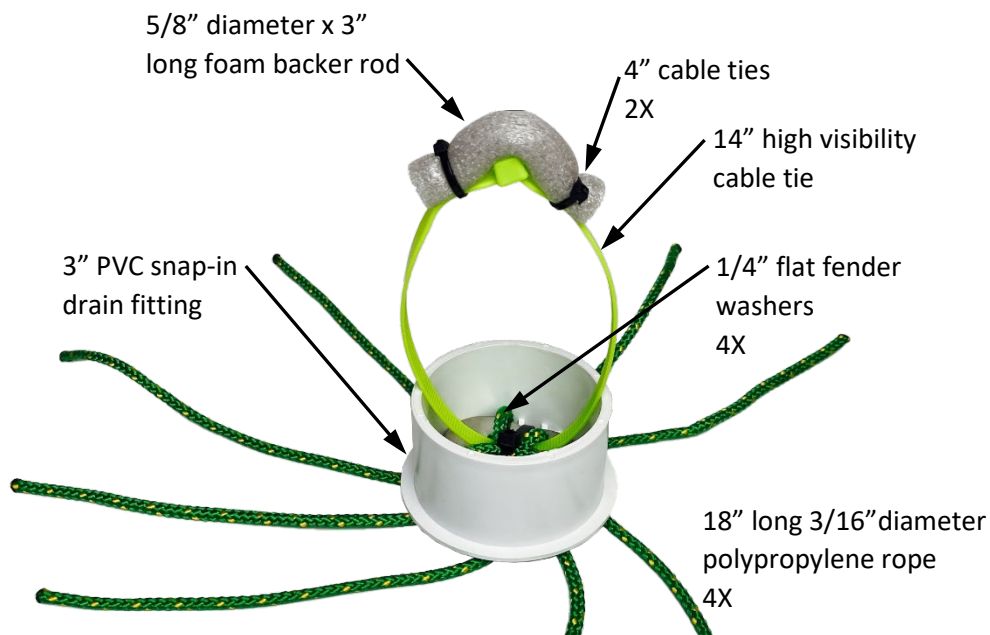
### Construct the small octopus.

Follow the same construction steps used for the large octopus with the following exceptions:

Use a 3" PVC snap-in drain fitting.

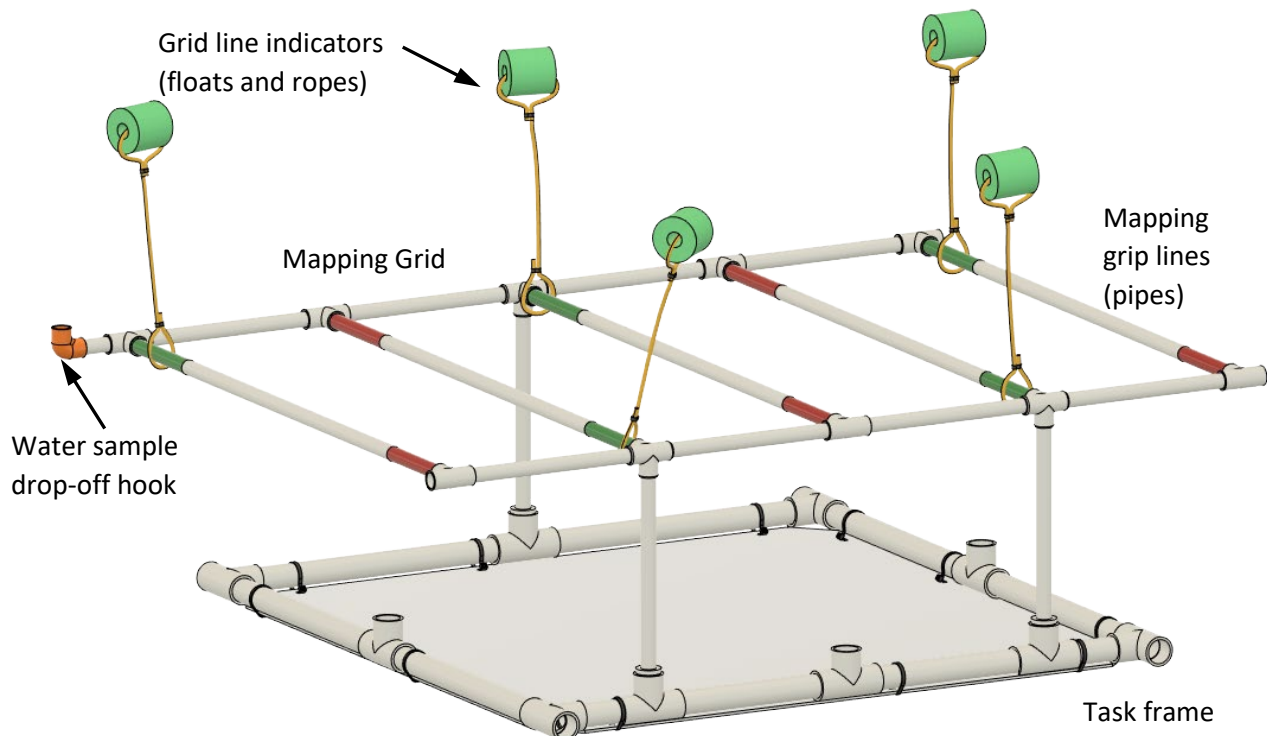
Use 18" long ropes.

Cable ties are not needed underneath the drain fitting on the ropes that pass through the washers. The washers are held in place securely because they overlap each other and the 8" cable tie secures them.



## Mapping Grid Task

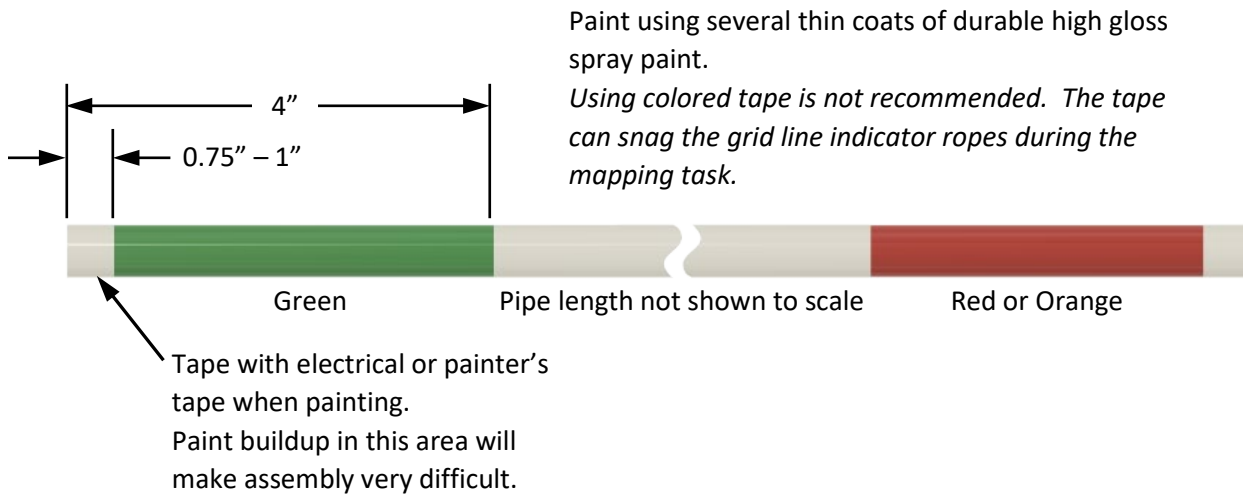
Mapping Grid Task Parts List		
Item	Unit	Qty.
1/2" Sch 40 PVC Tee	Each	7
1/2" 4-Way Tee ( <i>furniture grade</i> )	Each	3
1/2" Sch 40 PVC Pipe X 11" Long	Each	8
1/2" Sch 40 PVC Pipe X 34.75" Long	Each	5
1" X 1/2" Sch 40 Reducing Bushing	Each	3
1" PVC Snap-On Saddle Tee	Each	2
1/4" Polypropylene Rope x 24" Long	Each	5
8" Cable Tie ( <i>may be substituted with other sizes</i> )	Each	10
2.5" Diameter x 2.5" Long Pool Noodle	Each	5
#8 X 5/8" Stainless Steel Flanged Head Self-Drilling Screw	Each	34
1/2" Sch 40 PVC Elbow (reuse from 2022 Battery Pallet)	Each	1
1/2" Sch 40 PVC Pipe X 3" Long (reuse from 2022 Battery Pallet)	Each	1
Durable high-gloss spray paint (green and red or orange)		





### Construct the mapping grid

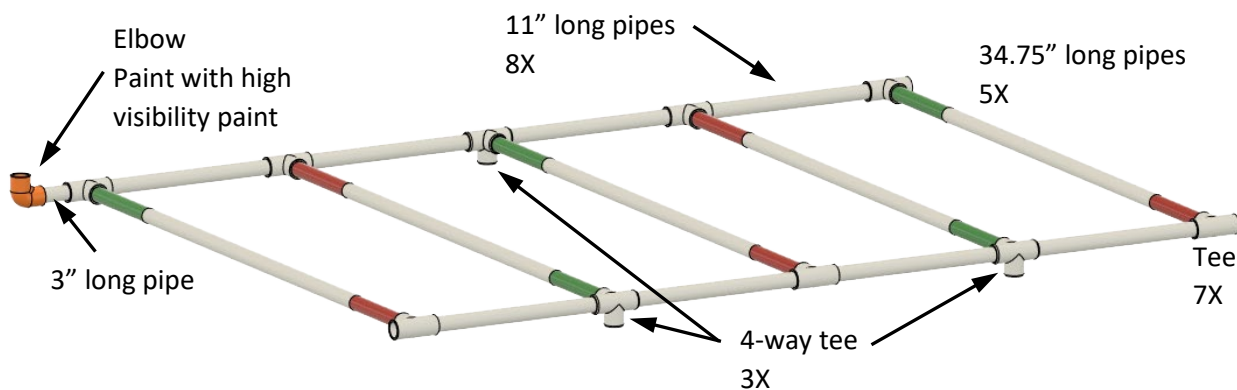
Paint the 34.75" long grid line pipes before assembly.



### Assemble the mapping grid

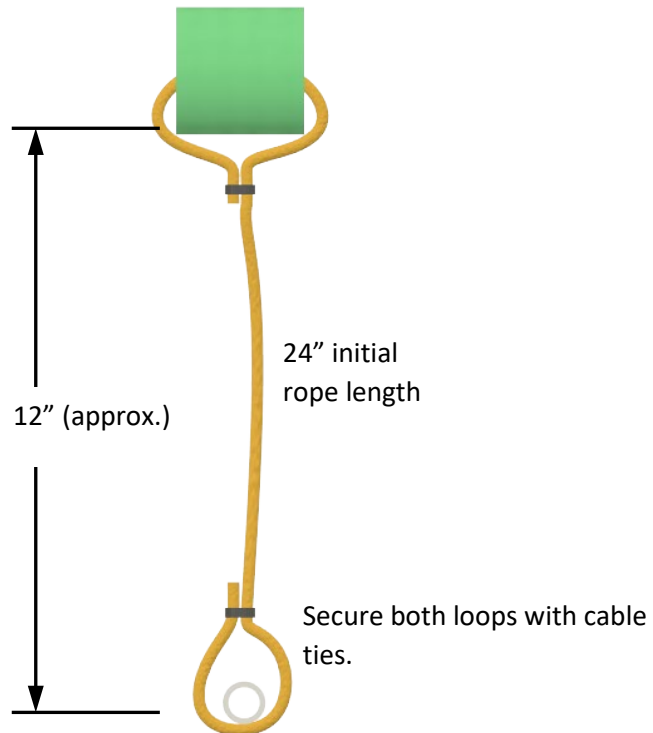
Alternate orientation of colored ends on the grid line pipes.

The green end of the first pipe should be in the corner with the water sample drop-off hook. This will assure that the first grid line indicator is out of the way when the ROV attempts to drop off the water sample.



### Construct five mapping grid line indicators

Secure the grid line indicators' lower rope loop around the grid lines during construction of the grid line indicator.



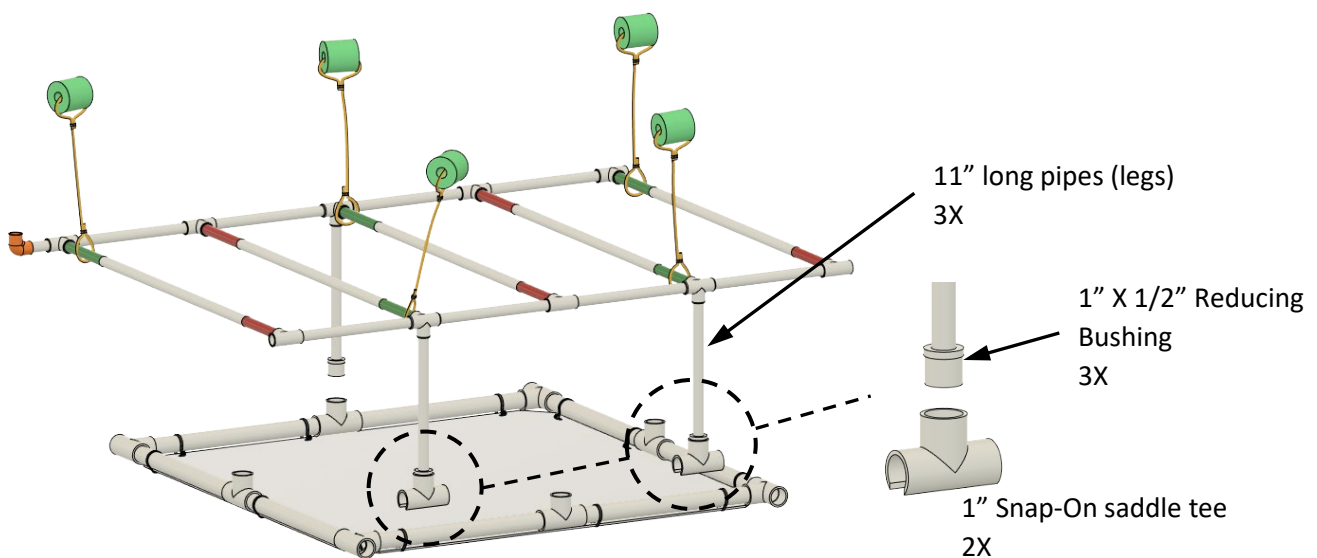
Mount the mapping grid on the task frame

Attach the 11" pipes (legs) to the mapping grid.

Attach the reducing bushings to all three 11" long pipes.

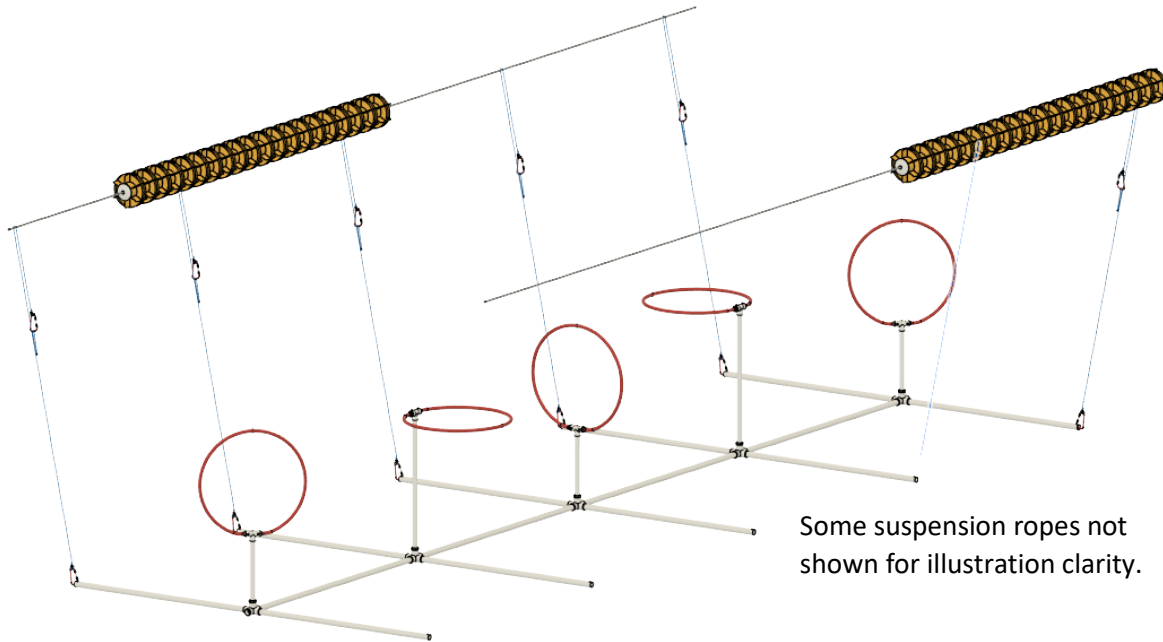
Attach the snap-on tees to the reducing bushings on the two pipes as shown. You do not need the snap-on saddle tees if you modified the task frames per the optional construction method on page 6.

Attach the mapping grid to the task frame.



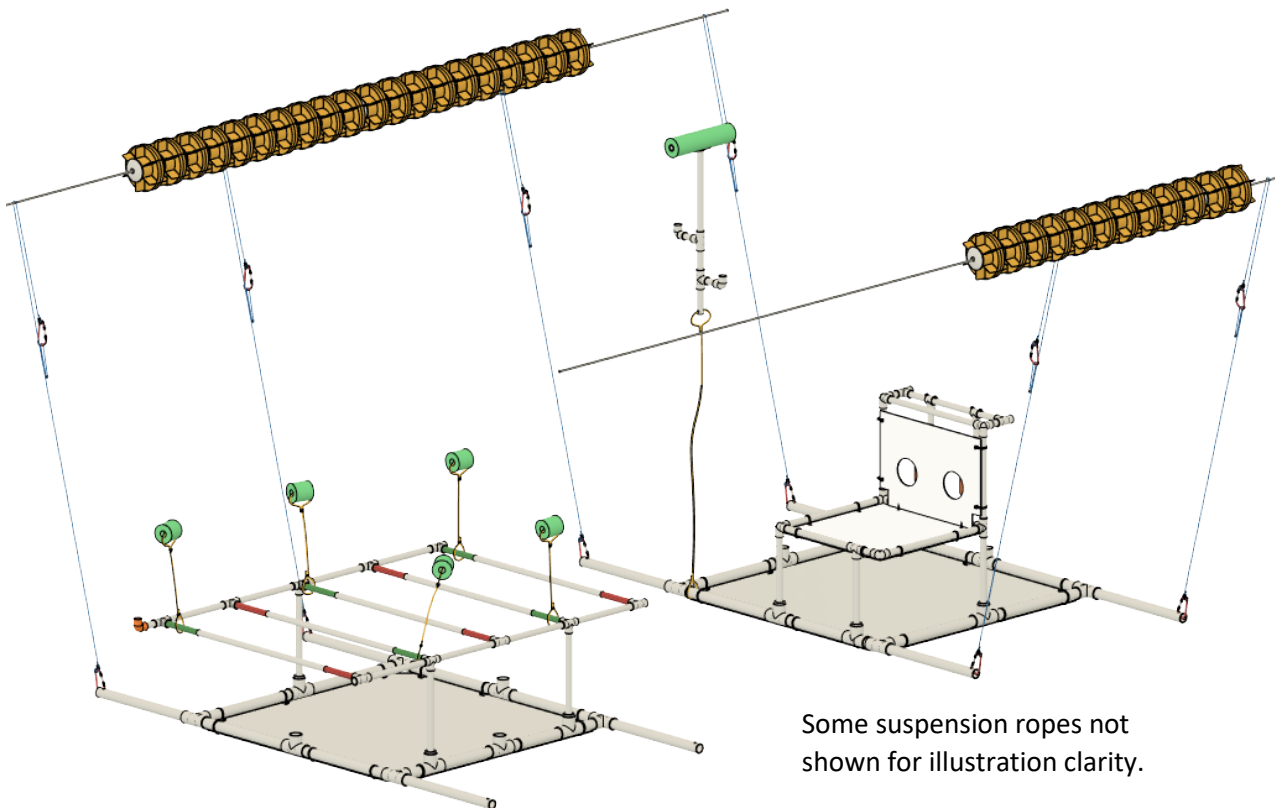


## Suspended Obstacle Course Reference



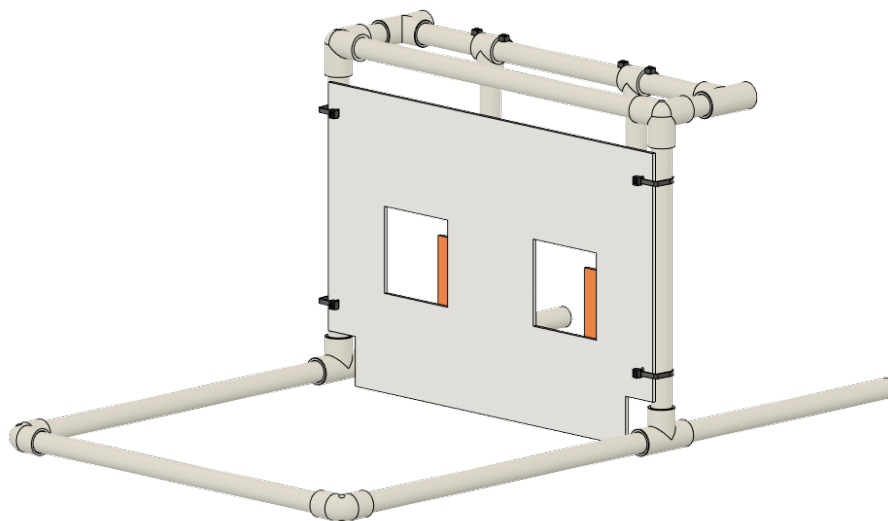
Some suspension ropes not shown for illustration clarity.

## Suspended Mission Course Reference

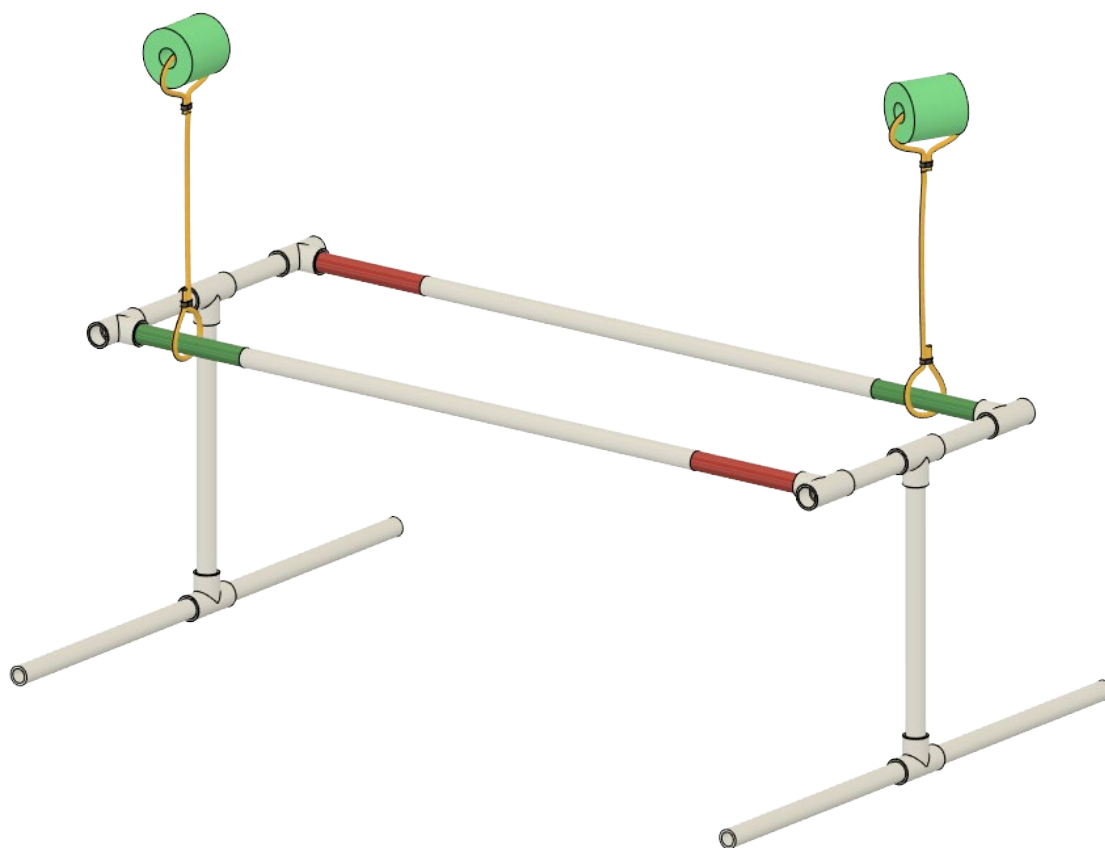


Some suspension ropes not shown for illustration clarity.

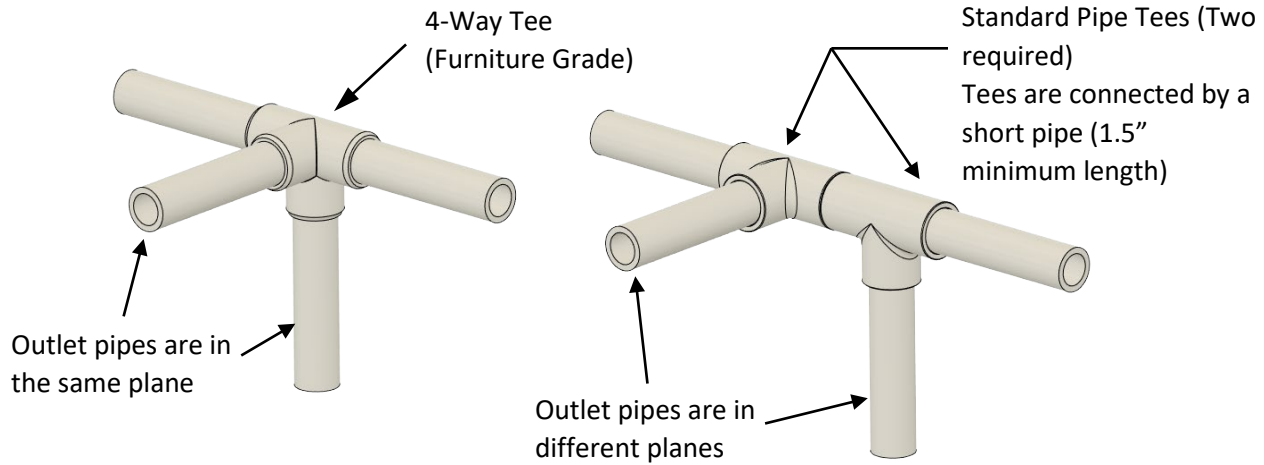
### Target Practice Course Idea



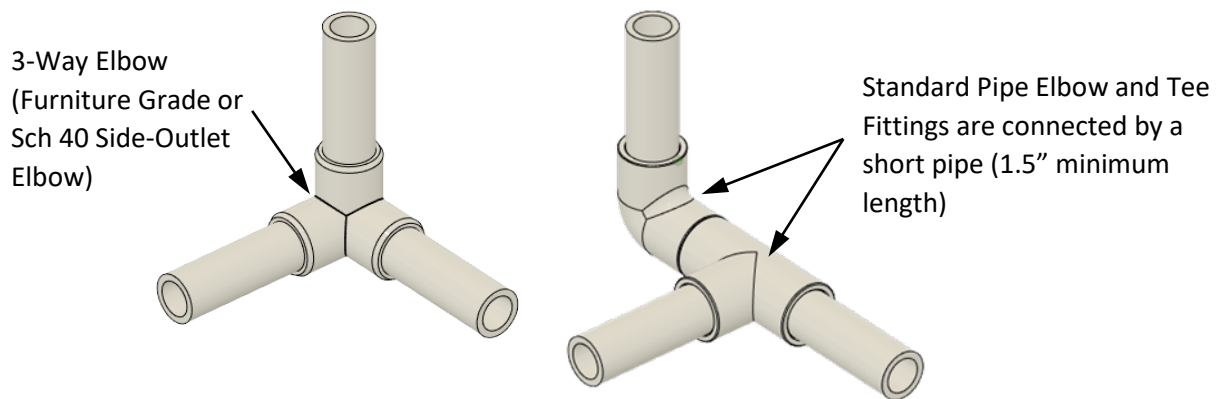
### Mapping Practice Course Idea



## Alternatives to Using Special Fittings



4-Way Tee Alternative



3-Way Elbow Alternative