

SCOUT PROP BUILDING INSTRUCTIONS & PHOTOS

Companies should be aware that tolerances in lengths of cut pipe and length of pipe inserted into joints can change the overall dimensions of product demonstration tasks. Certain non-critical dimensions may be changed to better work within the pool venue. Companies should expect tolerances in all product demonstration props, and should build their ROVs and tools accordingly.

Home Depot part numbers are given for certain construction items. However, some Home Depot stores may not carry the listed items. If the local Home Depot does not carry the part in question, MATE recommends checking other local hardware stores or online sources, such as those listed below, for the required component.

<http://www.pvcfittingsonline.com/>

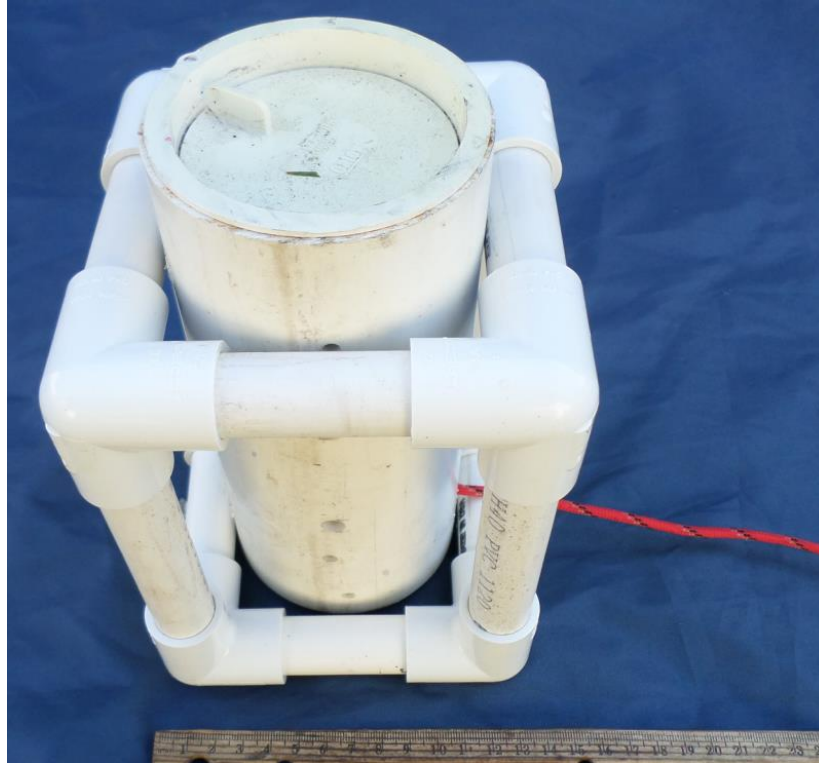
<http://pvcpipesupplies.com/pvc-fittings/schedule-40-pvc-fittings/>

Task 1: Outer Space: Mission to Europa

Environmental Sample Processor and Elevator

The Environmental Sample Processor is constructed from a 3-inch PVC pipe with a ½-inch framework around it. To construct the ESP:

1. Cut four 7.5 cm lengths of PVC pipe. Use four ½-inch side outs in combination with the 7.5 cm lengths of pipe to create a square. Make sure the remaining openings on the side outs all face the same direction.
2. Cut four 12 cm lengths of pipe. Insert a 12 cm length of pipe into each open end of the four side outs.
3. Repeat step 1 to make a second square of ½-inch PVC pipe and side outs. Attach this square to the four ends of the 12 cm lengths of PVC pipe.
4. Cut a 20 cm length of 3-inch pipe. Insert this pipe between the ½-inch PVC framework. One end of the 3-inch pipe should be flush with one side (the bottom) of the PVC framework. The other end of the 3-inch pipe should stick up approximately 3 cm from top of the framework.
5. Use 2-inch screws to secure the 3-inch pipe into the framework.
6. Insert a 3-inch knock out cap (Home Depot part #39102, internet #100122751, Store SKU #508260) into the top end of the 3-inch pipe.
7. Cut a 3 meter length of 1/8-inch polypropylene rope (Home Depot part #72402, internet #205804755, Store SKU #402816). Drill a 3/16-inch hole into the bottom edge of the 3-inch PVC pipe. Insert one end of the 3 meters of rope into the hole and tie an overhand knot to secure the rope inside the pipe.

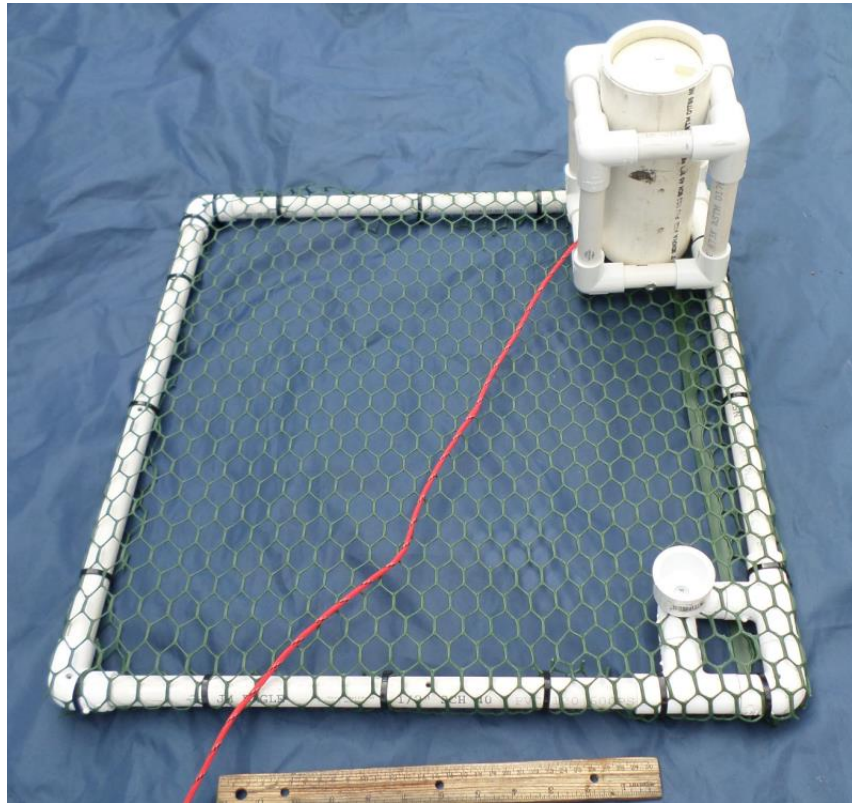


SCOUT product demonstration build photo #1: The Environmental Sample Processor.

Note: If you use side outs that are threaded in one opening, you will need to insert male adapters into those threaded openings. Make sure the threaded openings are open ends after creating the squares (step 1 and step 3). To compensate for the extended length, you will need to reduce the length of the 12 cm pipe. The entire length of the framework should be approximately 18 cm.

To construct the elevator:

1. Cut two 47 cm lengths, two 42 cm lengths and two 3 cm lengths of $\frac{1}{2}$ -inch PVC pipe. Insert a 42 cm length and a 3 cm length of pipe into the side openings of a PVC tee. Repeat this for the other 42 cm and 3 cm lengths of pipe. This gives you four 47 cm long lengths of pipe, two of which have tees near one end.
2. Connect the four 47 cm lengths of $\frac{1}{2}$ -inch PVC pipe. Use four $\frac{1}{2}$ -inch 90° elbows to create a PVC square approximately 50 cm long on each side. Have the two tees adjacent to each other in the square; twist the middle openings of the tee so they face the inside of the square.
3. Cut two 3 cm lengths of $\frac{1}{2}$ -inch PVC pipe and insert them into the middle openings of the two PVC tees. Connect the other ends of these two 3 cm lengths of pipe with a $\frac{1}{2}$ -inch 90° elbow.
4. Cover the bottom of the elevator with plastic mesh (Home Depot part #090786, internet #100384027). Secure the mesh with zip ties or duct tape.
5. Use a screw to secure a 1-inch end cap, open side facing upwards, to the 90° elbow that sticks in from one corner.
6. Use zip ties to secure the bottom of the ESP into one corner of the elevator that is adjacent to the 1-inch end cap.



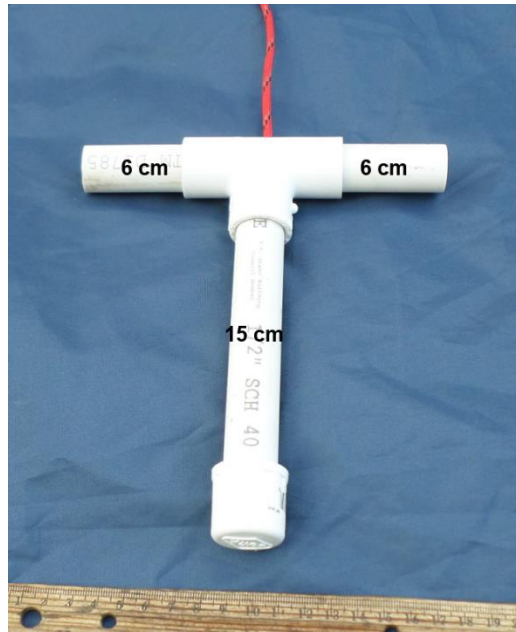
SCOUT product demonstration build photo #2: The elevator with the ESP attached.

Notes: Use rebar inside the ½-inch pipes of the elevator, or use dive weights, to keep the elevator stationary on the bottom of the pool.

Cable Connector

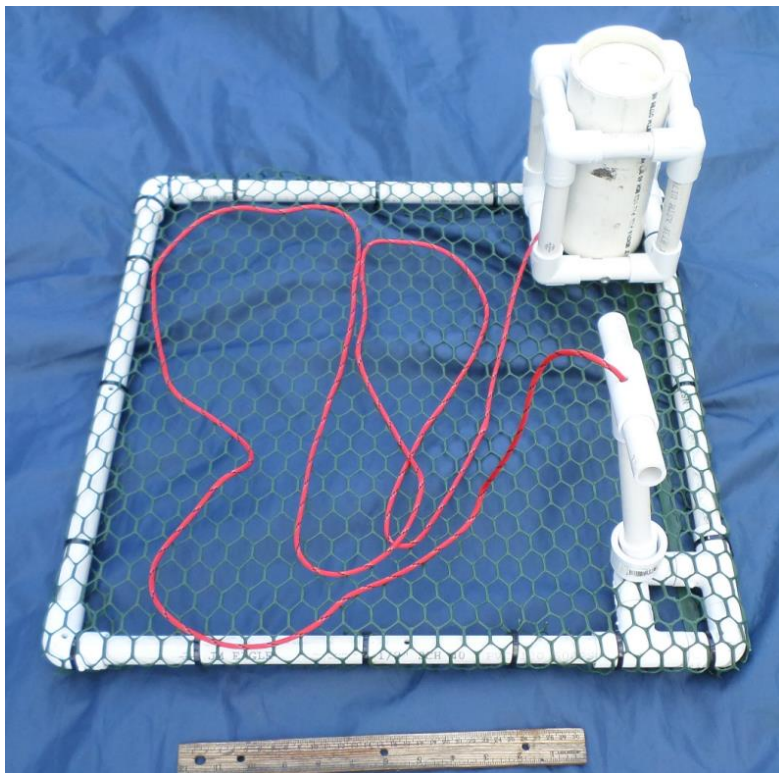
The cable connector is constructed from ½-inch PVC pipe and will rest upright in the 1-inch end cap mounted on the elevator. To construct the cable connector:

1. Cut a 15 cm length of ½-inch PVC pipe. Attach the middle opening of a PVC tee to one end; attach a ½-inch end cap to the other end of the length of pipe.
2. Cut two 6 cm lengths of ½-inch PVC pipe. Insert them into the two side openings of the PVC tee. Insert flotation into the tee and two 6 cm lengths of pipe. This flotation should make the cable connector lighter, but it should still be negatively buoyant.



SCOUT product demonstration build photo #3: The cable connector.

The ½-inch end cap of the cable connector is placed into the 1-inch end cap secured to the elevator. The 3 meters of cable (rope) should be coiled neatly on the remaining open section of the elevator. Note: Make sure the elevator with the ESP is within 2.5 meters of the power and communications hub.



SCOUT product demonstration build photo #4: The ESP, cable connector and 3 meters of coiled line on the elevator.

Power and Communications Hub

The power and communications hub is constructed from a milk crate. The door to the hub is constructed from corrugated plastic sheeting. The port on the power and communications hub is constructed from 2-inch PVC pipe.

Note: The power and communications hub is based off the RANGER cargo container from the 2014 MATE competition. Remove the locking mechanism and stand from the 2014 cargo container and cut off 2 cm from the bottom of the corrugated plastic sheet making up the door (so the door opens easily without impacting the bottom of the pool).

To construct the power and communications hub:

1. Cut a 32 cm by 32 cm sheet of corrugated plastic. Position the corrugated sheet on the open side of the milk crate. Use two 3-inch brass hinges to secure the corrugated plastic sheet over the open side of the milk crate.
2. Position the hinges along the edge of the milk crate and drill holes into the plastic of the milk crate and into the corrugated plastic.
3. Use #10-24 1-inch long bolts instead of the screws that come with the hinges. This will eliminate the sharp points of the screws and allow for tighter connections with the plastic. Use a 10-24 nut to secure the bolts through the hinges. When attaching the bolts through the corrugated plastic, use a 1 ¼-inch x ¼-inch fender washer on the two outside bolts of each hinge. This will increase the surface area against the corrugated plastic and prevent damage.
4. Cut a 9 cm length of ½-inch PVC pipe. Attach a ½-inch 90° PVC elbow to each end. Cut two 3 cm lengths of ½-inch PVC pipe. Insert those lengths in to the other end of the 90° PVC elbows. Attach a ½-inch 45° elbow to the other end of each 3 cm length of pipe.
5. Drill two 5/32-inch holes into the open end of each 45° PVC elbow. This is the handle to open the corrugated plastic top of the power and communications hub.
6. Place the handle on the side of the corrugated plastic opposite the hinges, 3 cm from the edge of the plastic. The handle should be positioned so the open ends of the 90° PVC elbow are flat against the corrugated plastic and the handle is located centrally between the two holes cut into the corrugate plastic.
7. Drill four holes into the corrugated plastic, each one adjacent to the holes drilled into the open end of the 90° PVC elbow. Insert cable/zip ties through the holes of each 90° PVC elbow, through the holes in the corrugated plastic. Tighten the ties to secure the handle to the corrugated plastic.
8. Cut a 27 cm length of 3-inch PVC or ABS pipe. Paint the final 3 cm of one end of the 27 cm length of pipe red, both the inside and outside of the pipe.
9. When the paint has dried, use zip ties to secure the 3-inch pipe to an inner side wall of the milk crate. The red painted end of the pipe should be facing the door and flush with the opening of the milk crate.

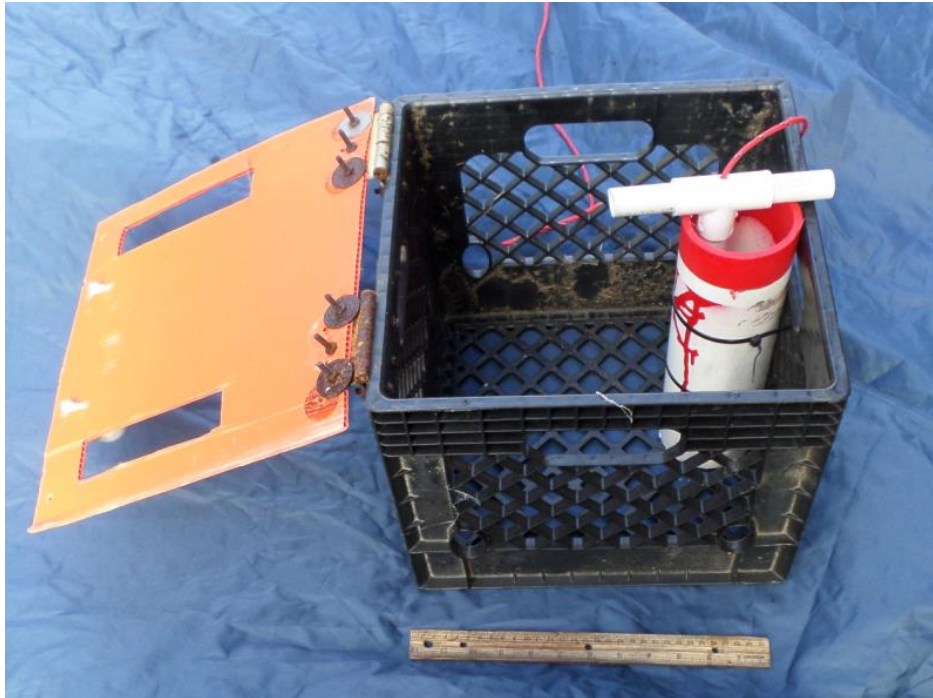


SCOUT product demonstration build photo #5: The power and communications hub with the door closed.



SCOUT product demonstration build photo #6: The power and communications hub with the door opened, exposing the 3-inch port.

Note: The rectangular openings on the corrugated plastic door are optional. They are remnants from the 2014 competition props.



SCOUT product demonstration build photo #7: The cable connector successfully inserted into the port on the power and communications hub.

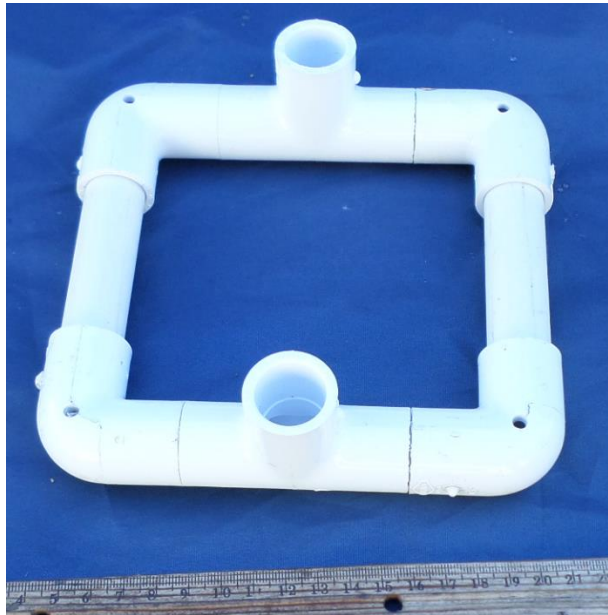
Position the milk crate on the bottom of the pool with the door facing upwards. Use weights to keep the power and communications hub from moving along on the bottom.

Task 2: Inner Space: Mission-critical equipment recovery

CubeSats

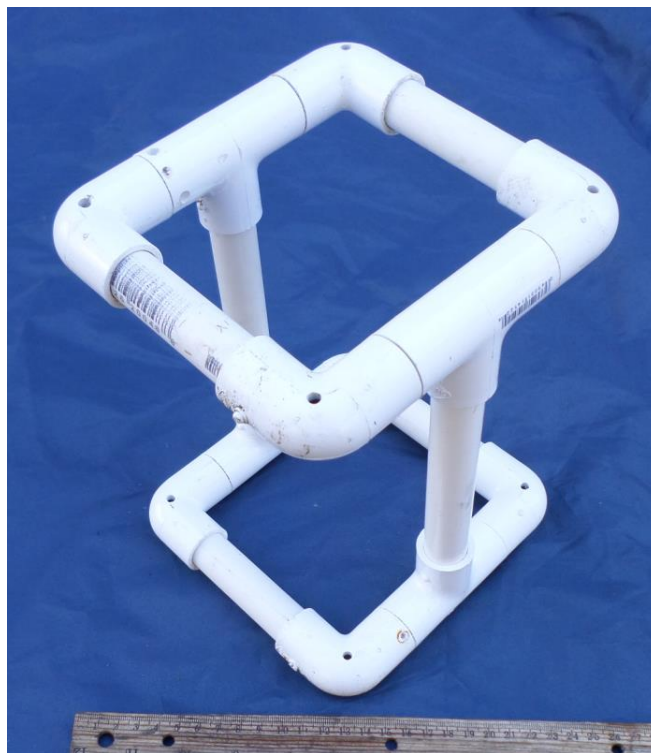
The CubeSats are constructed from ½-inch PVC pipe and corrugated plastic sheeting. All four CubeSats are identical in construction. To construct a CubeSat:

1. Cut two 3 cm lengths of ½-inch PVC pipe. Insert these two lengths into the two side openings of a ½-inch PVC tee. Attach a 90° elbow to the end of each 3 cm length of pipe. This will give you a tee with two elbows on each end.
2. Cut two 10 cm lengths of ½-inch PVC pipe. Insert the lengths of 10 cm pipe into the open ends of the two 90° elbows.
3. Repeat step 1 to create a second tee with elbows on each side.
4. Attach the open ends of the two 90° elbows to the two ends of the 10 cm lengths of pipe. This should create a ½-inch PVC square approximately 17 cm per side. Set the square flat on the ground and rotate the middle openings of the two PVC tees so the opening faces up.
5. Repeat steps 1 through 4 to create the other end of the CubeSat.



SCOUT product demonstration build photo #8: One end of a CubeSat.

6. Cut two 16 cm lengths of 1/2-inch PVC pipe. Insert these lengths of pipe into the middle openings of the two PVC tees on one end of the CubeSat. Attach the middle openings of the PVC tees of the other end of the CubeSat to the 16 cm lengths of pipe. This should create a rectangular prism 21 cm x 17 cm x 23 cm.



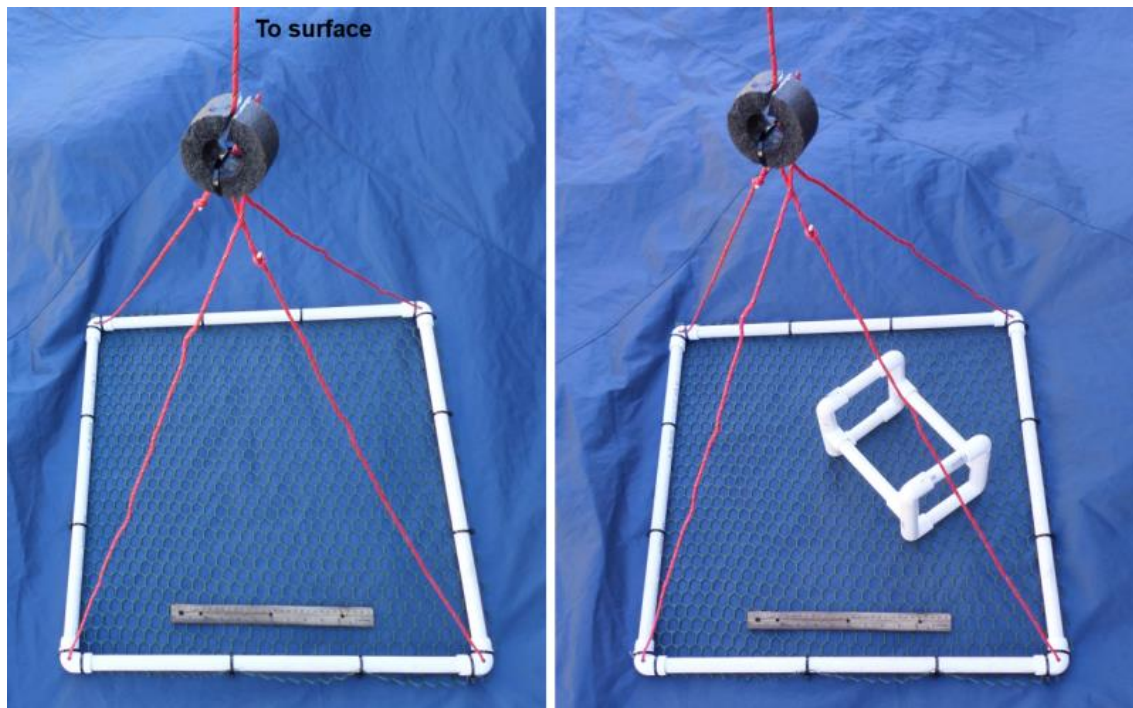
SCOUT product demonstration build photo #9: A CubeSat.

Repeat these steps to create four CubeSats.

Lift Basket

The lift basket is constructed from ½-inch PVC pipe and plastic mesh. To construct the lift basket:

1. Cut four 57 cm lengths of ½-inch PVC pipe. Use four ½-inch 90° elbows to create a square that is 60 cm per side.
2. Cut a 62 cm x 62 cm square of plastic mesh (Home Depot part #090786, internet #100384027). Use zip ties to attach the square of plastic mesh to the 75 cm PVC square.
3. Cut four 1 meter lengths of 1/8-inch polypropylene rope (Home Depot part #72402, internet #205804755, Store SKU #402816). Drill a 3/16-inch hole into each 90° elbow at the corners of the PVC square. Insert a 1 meter length of rope into each hole. Tie an overhand knot to secure the rope inside the elbow.
4. Bring the four loose ends of the ropes together and tie a knot to secure them. Attach a small float to keep the ropes suspended above the lift basket.
5. Cut another length of 1/8-inch polypropylene rope that will reach from the connection of the four ropes to the surface. Tie one end of this rope to the connection of the four 1 meter lengths of rope. The other end of the rope should be attached to a solid object on the surface, side of the pool.



SCOUT product demonstration build photo #10: Photo on left shows the lift basket for the four mission-critical CubeSats. Ropes at each corner come together at a float above the lift basket and extend to the surface, side of the pool. Photo on right shows one CubeSat in the lift basket.

Task 3: Inner Space: Forensic Fingerprinting

Oil mat

The oil mats are constructed from a 5-gallon bucket lid. One oil sample will sit on top of each 5-gallon bucket lid. To construct an oil mat, paint the top side of one 5-gallon bucket lid black.

Oil samples

The oil samples are constructed from a 2-inch PVC tee. The oil samples are painted black. A U-bolt is attached to each oil sample as a grab point. To construct an oil sample:

1. Paint a 1 ¼-inch end cap black. Use two screws to attach the end cap, open side up, to the center of the painted bucket lid.
2. Drill two ¼-inch holes 2.7 cm on either side of the centerline on the top of a 2-inch PVC tee (the top is the side opposite the middle opening). Insert a #310 U-bolt (Home Depot model #806826, internet # 204273753, Store SKU # 117996) into the two holes. Use nuts to secure the U-bolt in place. The U-bolt should rise 7.5 cm above the top of the 2-inch tee.
3. Paint the oil sample black. When the paint has dried, place the middle opening of the 2-inch PVC tee over the 1 ¼-inch end cap attached to the 5-gallon bucket lid.



SCOUT product demonstration build photo #11: An oil mat without an oil sample.



SCOUT product demonstration build photo #12: An oil sample.



SCOUT product demonstration build photo #13: Oil mat with oil sample.

A gas chromatograph will be rolled up inside each oil sample. The gas chromatograph will be printed on a laminated sheet approximately 22 cm by 12 cm. Examples of gas chromatographs can be seen in the **SCOUT Oil Fingerprint Handbook**.

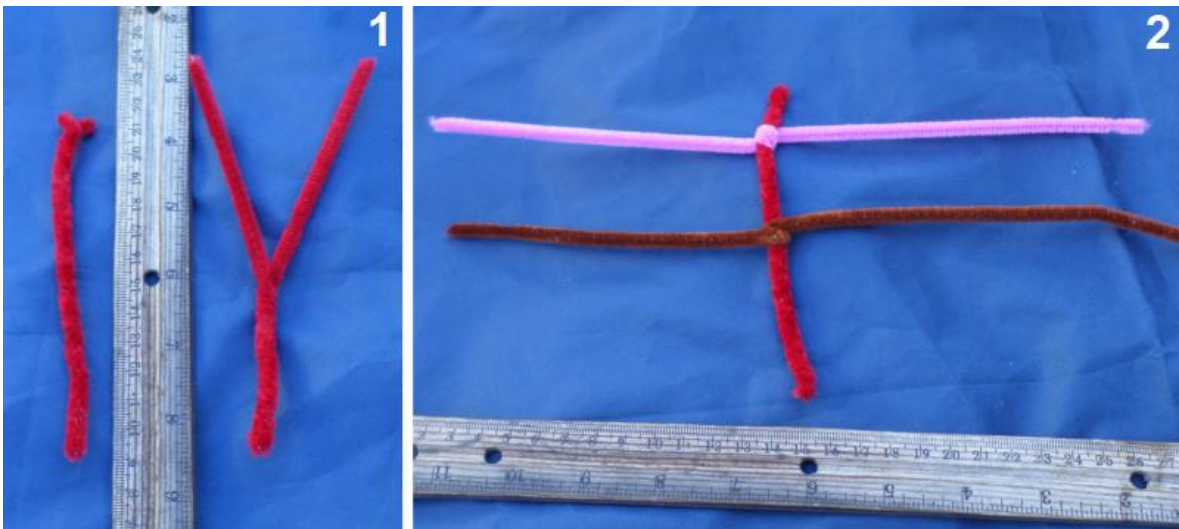
Task 4: Inner Space: Deepwater coral study

Madrepora Coral

The scleractinian coral colony *Madrepora prolifera* is constructed from brown, red and pink chenille pipe cleaners. Colors may vary in different coral colonies. The base of the coral colony is a ½-inch PVC tee.

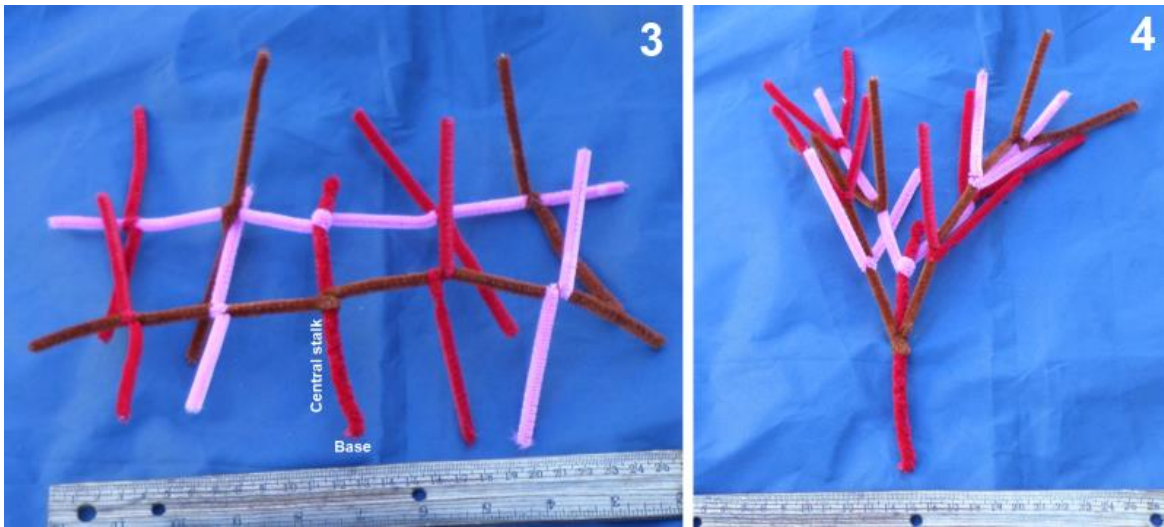
To construct the *Madrepora* coral:

1. Fold a red chenille pipe cleaner in half and twist it tightly together. This double strength pipe cleaner is the central stalk of the coral colony.
2. Take a brown pipe cleaner and wrap it three times around the red central stalk pipe cleaner, about half way between the two ends. Take a pink pipe cleaner and wrap it three times around the red central stalk pipe cleaner, about halfway between the brown pipe cleaner and one end.



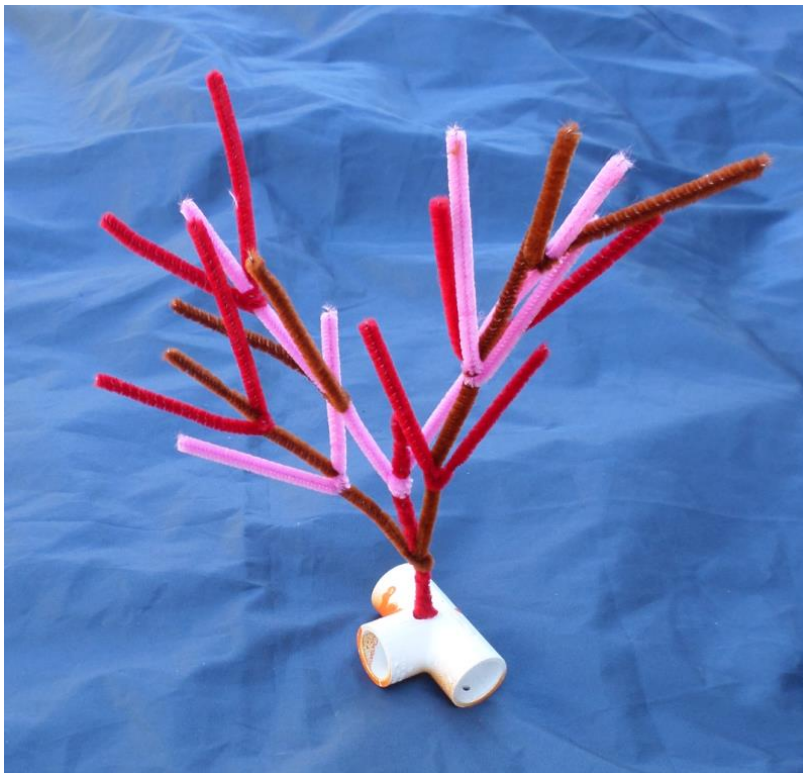
SCOUT product demonstration build photo #14: 1) The central stalk of the coral. Completed central stalk on left of ruler, half twisted central stalk on the right of the ruler. 2) Additional brown and pink chenille pipe cleaners added to the central stalk of the coral colony.

3. Cut a red pipe cleaner in half (two 15 cm lengths). Cut a pink pipe cleaner in half (two 15 cm lengths). Wrap a red pipe cleaner three times around one side of the brown pipe cleaner, about 5 cm from the central stalk. Wrap a pink pipe cleaner three times around the same side of the brown pipe cleaner, about 10 cm from the central stalk. Use the other 15 cm red and pink pipe cleaners on the brown pipe cleaner on the other side of the central stalk.
4. Cut a red pipe cleaner in half (two 15 cm lengths). Cut a brown pipe cleaner in half (two 15 cm lengths). Wrap these around the pink pipe cleaner that is wrapped around the central stalk, using the same method as step 3.
5. Twist all the pipe cleaners so the branches bend in one direction. Design note: The easiest way to do this is to grab the base with one hand, form a circle with your thumb and index finger of your other hand and run it up the central stalk two or three times. The base of the stalk is the side of the central stalk that does not have the second pipe cleaner (the longer side of the central stalk).



SCOUT product demonstration build photo #15: 3) Eight additional side branches added to the coral. Note the central stalk and base of the coral. 4) Coral colony with all branches positioned.

6. Drill two 3/16-inch holes into the center side of a ½-inch PVC tee. The holes should be 0.5 cm apart. Push the base of the center stalk into one hole and bend it out the other. Twist the ends of the base together to form a tight, strong base. The tight, strong base should be able to hold the coral colony upright in air.



SCOUT product demonstration build photo #16: Completed scleractinian coral colony with base.

Optional design 1: Cut a few more 15 cm lengths of various colored pipe cleaners. Add them into the coral colony to fill it out.

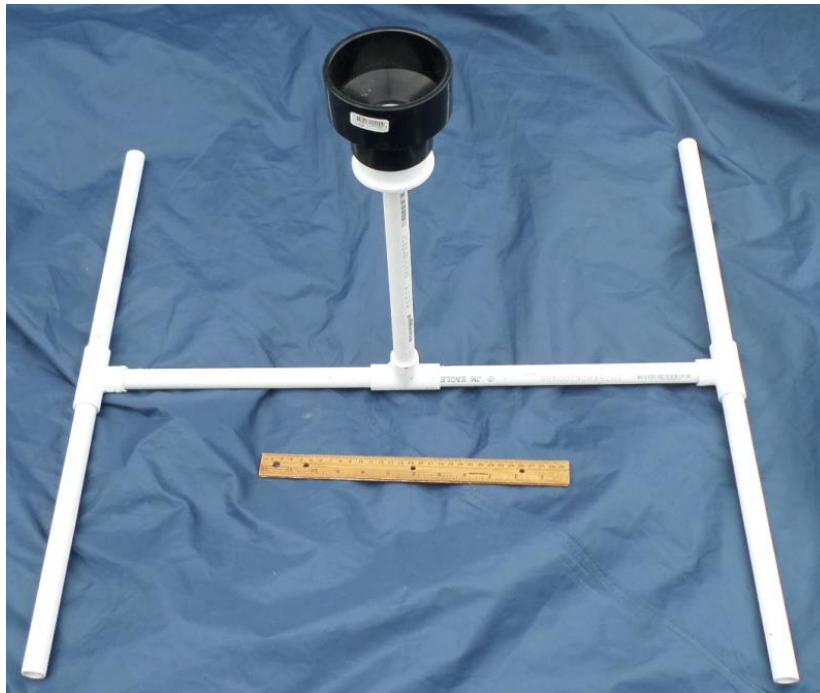
Optional design 2: Attach small bits of pink or red flotation to the top ends of a few coral branches. This flotation will help hold the coral upright in the water.

Task 5: Inner Space: Rigs to Reefs

Wellhead

The wellhead framework is constructed from ½-inch PVC pipe. The top of the wellhead is a 3-inch to 2-inch ABS adapter (Home Depot model # 02950H, internet # 205002023, Store SKU # 232521). A 2-inch to ½-inch reducer bushing (Home Depot model # C437-247, Internet # 100343810, store SKU # 744724) connects the adapter to the ½-inch PVC framework. To construct the wellhead:

1. Cut seven 30 cm lengths of ½-inch PVC pipe. Insert one 30 cm length of PVC pipe into the middle opening of a PVC tee. Install the 2-inch to ½-inch reducer bushing onto the other end of this 30 cm length of pipe. Attach the 3-inch to 2-inch adapter onto the other end of the reducer bushing.
2. Insert two 30 cm lengths of pipe into the two remaining side openings of the PVC tee. Attach the middle opening of a ½-inch PVC tee to the ends of the two 30 cm lengths of pipe.
3. Insert four 30 cm length of ½-inch pipe into the four side openings of the two PVC tees.

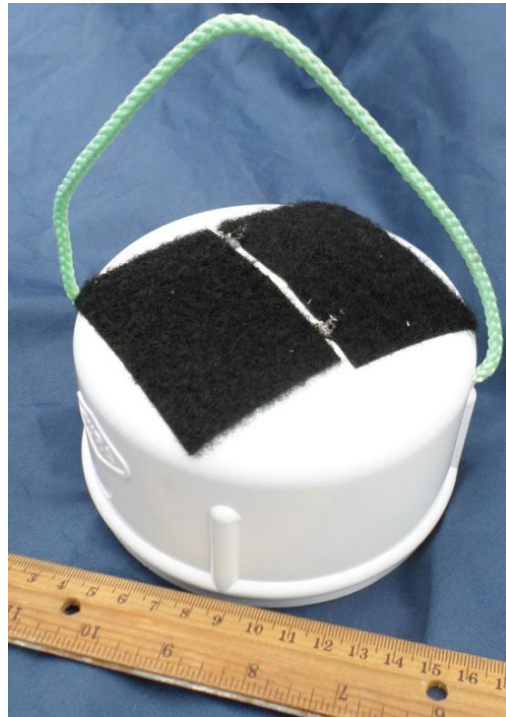


SCOUT product demonstration build photo #17: The wellhead.

Wellhead cap

The wellhead cap is installed on top of the wellhead. The wellhead cap is constructed from a 4-inch PVC end cap. Velcro loops are located on the top of the cap. A 40 cm length of 1/8-inch nylon rope (Home Depot model # 14068, internet # 202048182, Store SKU # 140287) serves as a lift point for the wellhead cap. To construct the cap:

1. Cut two 8 cm x 5 cm lengths of Velcro loops. Adhere these rectangles of Velcro to the top of the 4-inch end cap.
2. Drill two 3/16-inch holes in the top of the end cap between the two rectangles of Velcro loops.
3. Drill two 3/16-inch holes on opposite sides of the sidewall of the 4-inch end cap. The two holes should be 0.5 cm from the top rounded edge of the end cap.
4. Cut a 40 cm length of 1/8-inch nylon rope. Insert the ends of the nylon rope through the two holes drilled into the sidewalls of the end cap. Tie an overhand knot to keep the rope secured inside the end cap.



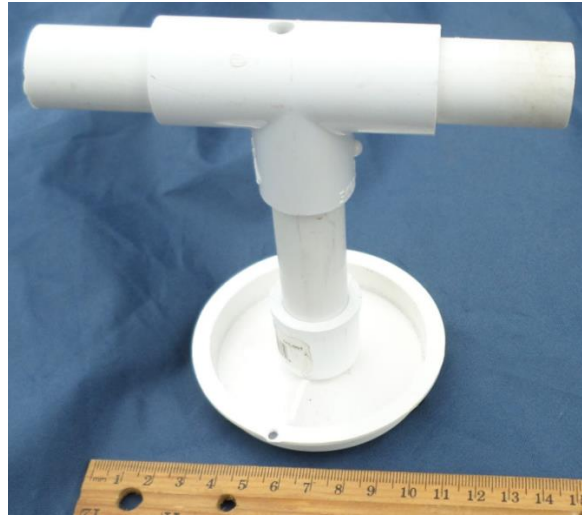
SCOUT product demonstration build photo #18: The wellhead cap.

Bolt

The bolt is connected to the top of the wellhead cap to secure the cap onto the wellhead. The bolt is constructed from a 3-inch knockout cap (Home Depot model #39102, Internet #100122751, Store SKU #508260) and 1/2-inch PVC pipe. Velcro hooks secure the bolt to the Velcro loops on the wellhead cap. To construct the bolt:

1. Screw a 1/2-inch PVC end cap in the center of the inside edge of a 3-inch knockout cap.
2. Cut an 8 cm length of 1/2-inch PVC pipe. Insert this pipe into the end cap. Install the middle opening of a PVC tee to the other end of the 8 cm length of pipe.

3. Cut two 5 cm lengths of ½-inch PVC pipe. Insert these two lengths of pipe into the side openings of the PVC tee.



SCOUT product demonstration build photo #19: The bolt.

4. Cut an 8 cm x 5 cm length of Velcro hooks. Adhere the Velcro rectangle to the outside bottom of the 3-inch knockout cap.



SCOUT product demonstration build photo #20: Velcro hooks on bottom of bolt.

Elevator

The elevator is a 30 cm x 30 cm square patio brick. If your pool venue will not allow patio bricks, you can construct an elevator out of a 30 cm x 30 cm PVC frame and corrugated plastic sheeting. The wellhead cap and bolt will rest upright on the plastic sheeting.



SCOUT product demonstration build photo #21: The elevator holding one wellhead cap and one bolt.

The elevator will have two wellhead caps and two bolts available for SCOUT class companies.

If you build an elevator out of PVC and corrugated plastic sheeting, use weights to secure it to the bottom.