



Central New York Rocket Team Challenge 2023

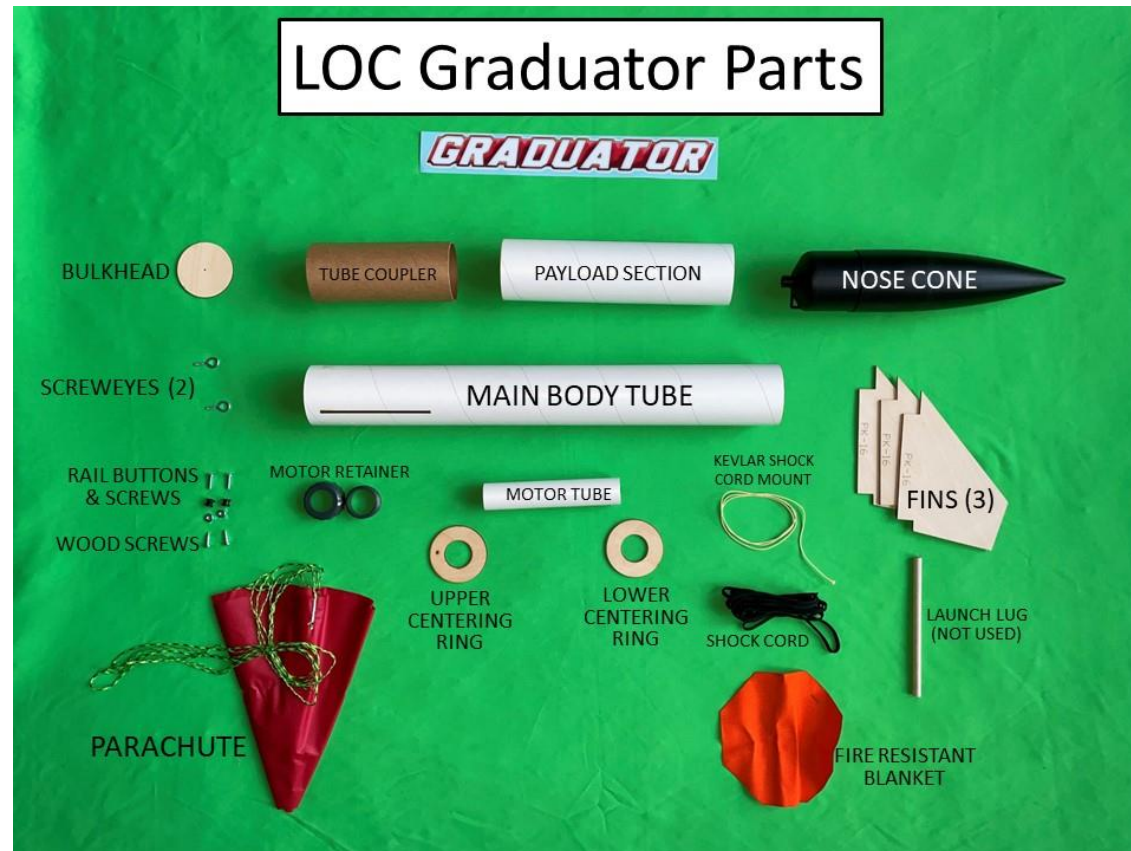
LOC Graduator Rocket Assembly Instructions

Note: These instructions vary from those provided by the manufacturer of the rocket kit. There is also considerable varying discussion that can be found on rocket web sites on construction methods. While the teams are allowed to assembly kits in a manner they see fit, these assembly instructions and methods are those recommended to complete a rocket to compete at the Central New York Rocket Team Challenge.



Getting Started

First, make sure you have all the parts you need to build the rocket. The picture will help you identify the components of the LOC Graduator kit as you work through these instructions.



Other items needed during assembly:

Ruler, wood glue (we recommend Titebond II), cyanoacrylate (super glue), 5 minute epoxy, masking tape, sandpaper, popsicle sticks (for glue application), rubber gloves, pen, modeling knife, and paper.

Motor Mount Sub-Assembly

The motor mount holds the rocket motor during flight and must be built to transfer the forces to the rest of the rocket. It is very important to glue the motor mount assembly securely.

- 1) Sand the entire outer surface of the motor tube. This will help the glue adhere to the surface.
- 2) Test-fit both centering rings on the end of the motor tube. They should fit snugly but not crimp or tear the end of the tube. If they are too tight, use coarse sandpaper to remove some material from the inside of each centering ring until a good fit is obtained.



- 3) Screw one screw eye into the upper centering ring.

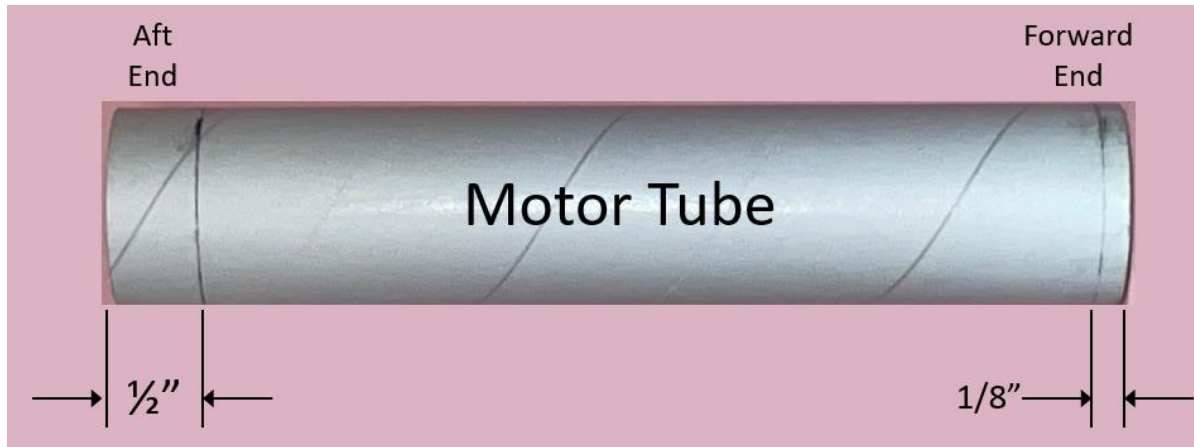
Glue Hints:

A light amount of glue will dry more quickly!

The recommended glue is "Titebond II" carpenter's glue.

Keep in mind that this glue will stain clothing!

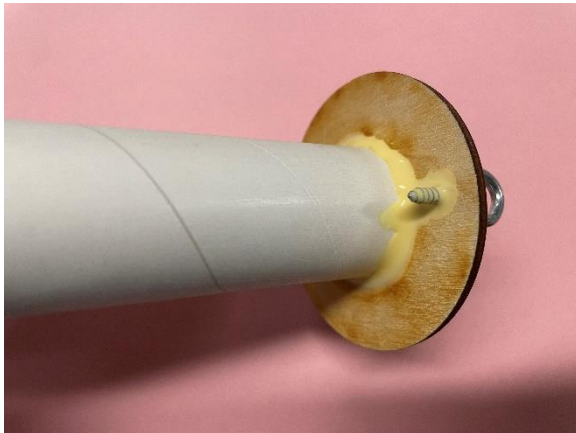
Two-part epoxy is stronger but requires greater care. Gloves must be worn when applying epoxy.



4) Mark the motor tube 1/8 inch from the forward end and 1/2 inch from the aft end.

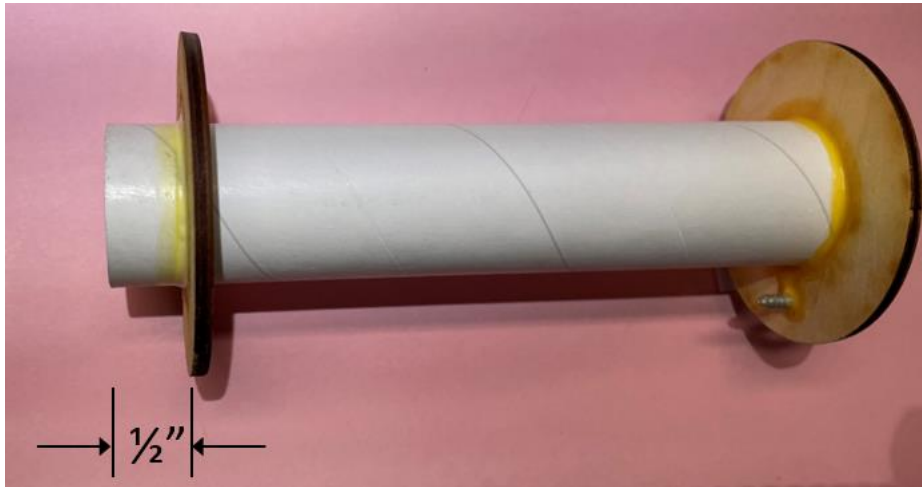
5) Place the upper centering ring at the mark 1/8-inch from the forward end of the motor tube.

6) Apply a line of glue at the joint of the tube and front ring. Smooth out the glue around the joint using a gloved finger. You may want to wear disposable gloves when applying carpenters wood glue. ALWAYS wear gloves when working with epoxy glue.



7) Repeat step 6 on the other side of this ring for added strength.

8) Apply glue around both sides of the screw eye on the upper centering ring.



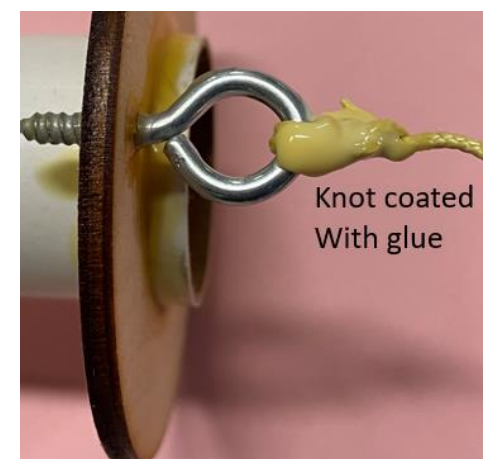
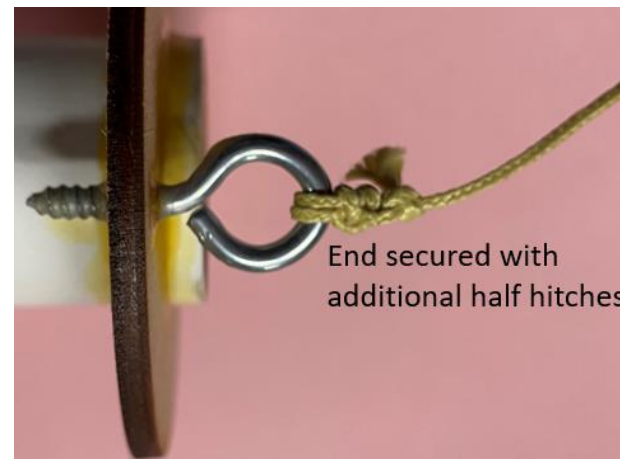
9) Place the lower centering ring on the aft end of the motor tube and slide it to the $\frac{1}{2}$ " mark. Be sure that there is $\frac{1}{2}$ inch between the end of the tube and the bottom of the centering ring. This provides space for installation of the motor retainer in a later step.

10) Allow the glue on the centering rings to fully dry before proceeding.

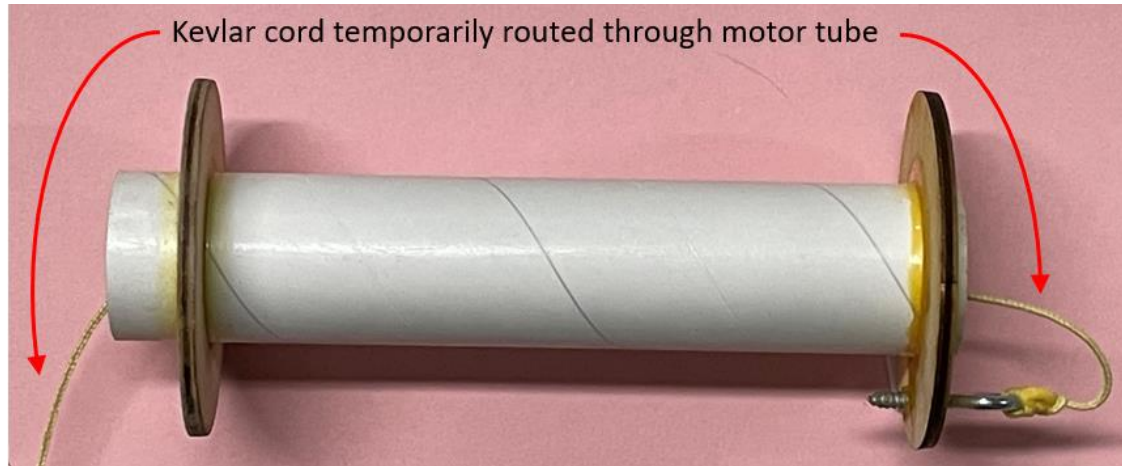
Installing the Motor Mount

In this section, you will glue the motor-tube/ring sub-assembly into place inside the main rocket body tube.

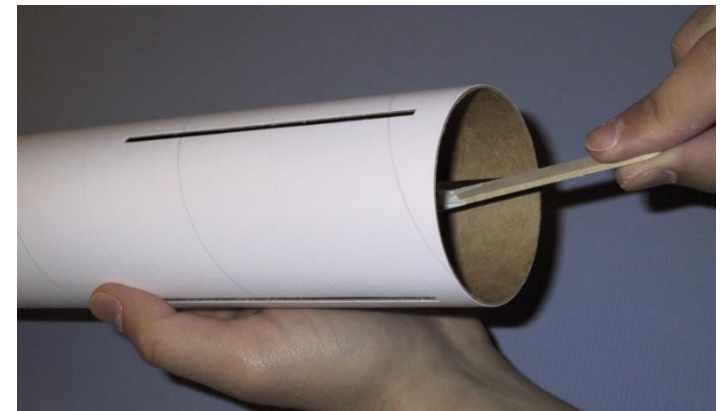
- 1) Test-fit the motor mount assembly into the end of the main tube that has the fin slots. The upper centering ring (with the screw eye) goes in first. It may be easier to initially slide it in a little off center, and then set it straight. If the centering rings fits too tightly, sand around the outer edge of the rings.
- 2) Tie the Kevlar shock cord mount to the screw eye. Many different knots can be used. The one shown is an anchor hitch, followed by two half hitches. See www.animatedknots.com/anchor-hitch-knot for knot tying instructions. Extra cord can be secured using additional half-hitches. Coat the knot with glue and allow the glue to dry.

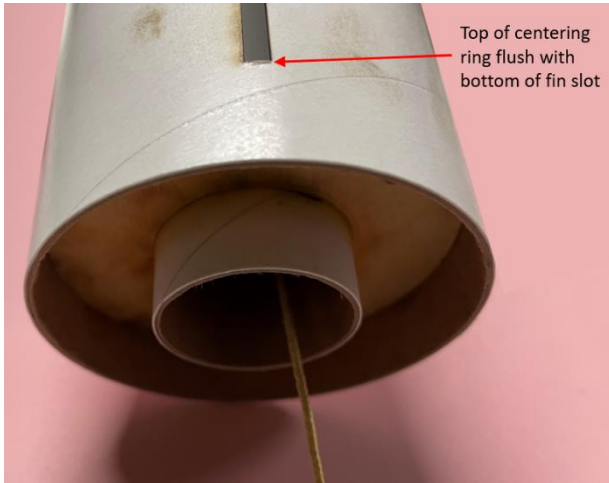


3) Feed the Kevlar cord through the top of the motor tube and out the bottom.



4) Apply a heavy ring of glue inside the main body tube just above the forward edge of the fin slots. Apply the glue using popsicle sticks (tape two of them together to make a longer stick). Keep the main tube horizontal to prevent the glue from running down the inside length of the tube.



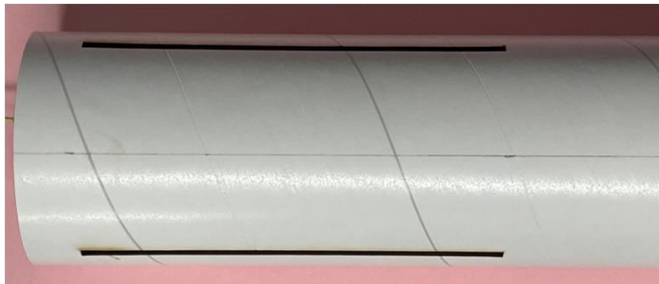


5) Slide the motor tube assembly into the bottom of the main tube until it hits the glued area. Continue pushing the tube in until the top of the lower centering ring is flush with the bottom of the fin slots. Check all three fin slots to be sure the centering ring is not blocking any part of any fin slot opening. If so, move the motor tube assembly downward so no fin slot is blocked.

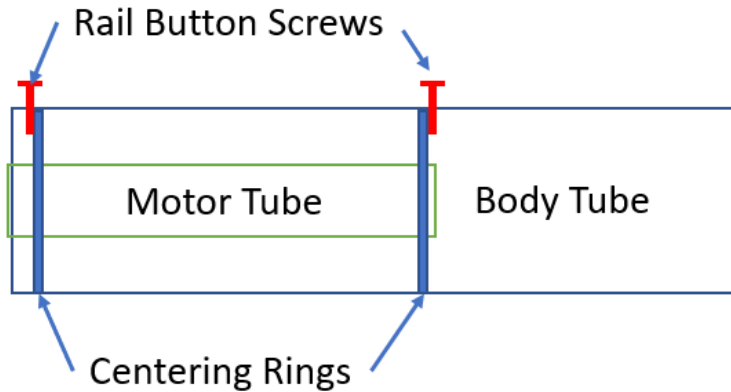
6) Keep the body tube upright and vertical until the glue is set.

Installing Rail Buttons

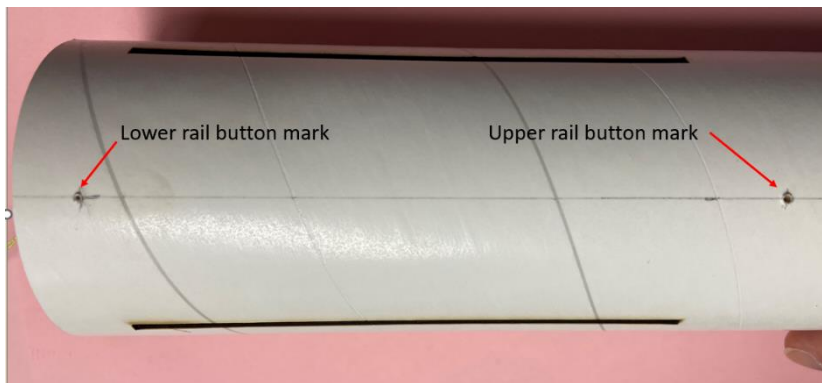
Rockets need initial guidance during the boost. At the Central New York Rocket Team Challenge, the LOC Graduator is guided by a 6 foot grooved rail. Two launch rail guides (rail buttons) need to be secured into the main body tube of the rocket vertically aligned between two fins.



1) Measure halfway between two fin slots and place a mark on the body tube. Draw a 10-inch line through the mark starting at the bottom of the body tube.



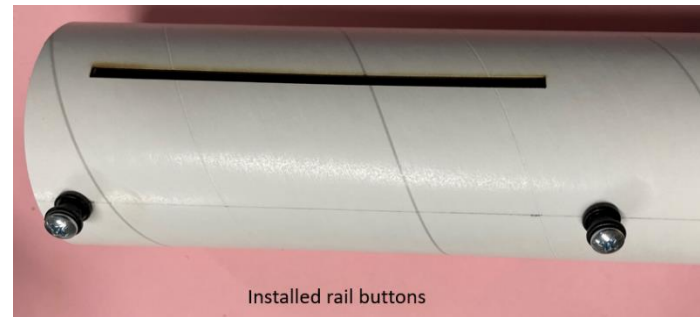
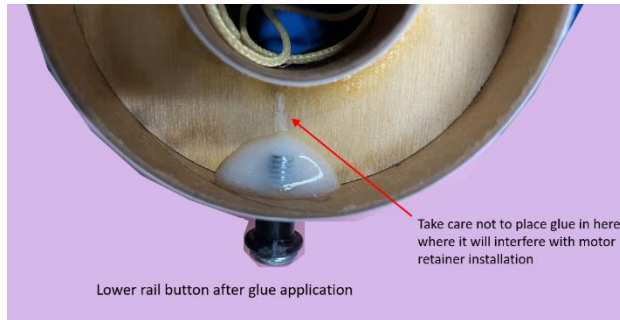
2) Rail buttons will be installed on the line drawn in step 1. The lower rail button hole will be drilled just aft of the lower centering ring such that the rail button screw touches the centering ring without drilling into the ring. The upper rail button hole will be drilled just forward of the upper centering ring such that the rail button screw touches the centering ring without drilling into the ring.



3) Measure from the aft end of the body tube to the bottom of the lower centering ring. Subtract 1/16 inch, and mark the resulting distance on the line drawn in step 1. Measure from the forward end of the body tube to the top of the upper centering ring. Subtract 1/16 inch, and mark the resulting distance on the line drawn in step 1.



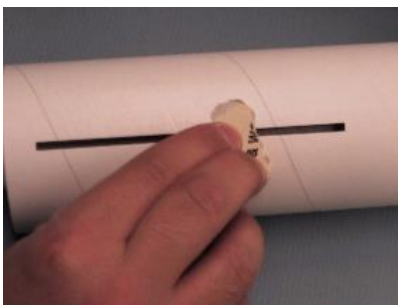
4) Drill a 1/8" hole at each rail button mark. The drill bit should be directly adjacent to the centering ring, but not drilled into the centering ring. Slide the rail button over the screw and turn the rail button screw into the hole to confirm that the screw is just touching the centering ring and is straight. If the rail button is crooked or the screw is not touching the centering ring, remove the screw and use the drill to widen the hole in the cardboard tube to correctly position the screw. Reinsert the rail button and screw and continue adjusting until the rail button is straight. When the screws are properly aligned, place epoxy glue over the portion of the rail button screw that is touching the centering ring.



When gluing the upper rail button screw, you will need to reach down from the top with a long stick to place the glue. Be sure to pull the Kevlar shock cord mount down through the motor tube to avoid getting glue on the Kevlar cord.

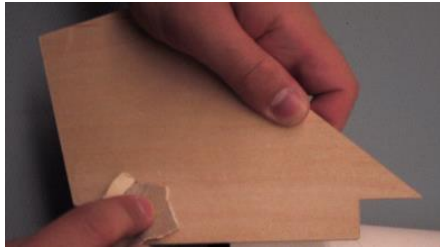
Attaching the Fins

The three plywood fins will be glued to the motor tube and the main body tube to guarantee a strong attachment to the rocket.

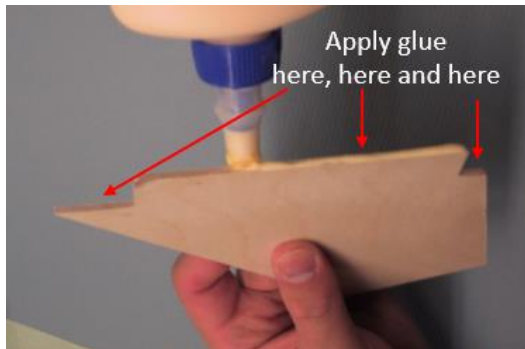


- 1) Lightly sand the outer surface of the main tube around the fin slots.

Fin Slots & Tabs:
 The fins are made with tabs that glue directly to the motor tube instead of the outside of the main body tube. This method creates a strong connection that minimizes fin joint breakage during launch & landing.



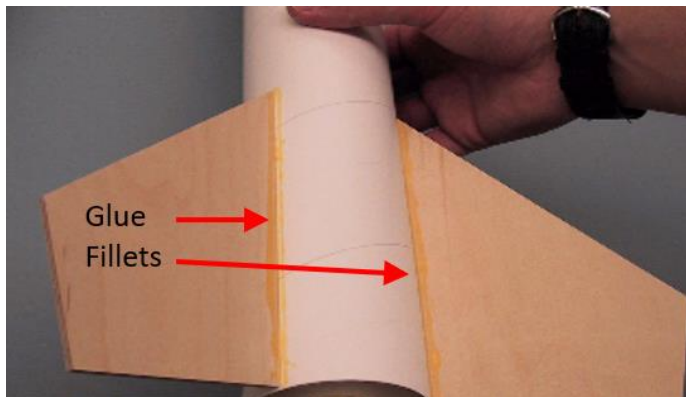
2) Sand the surface of the fins where they will meet the inside and outside edges of the fin slot. This will help the glue adhere to the fins. Test fit each fin into the slot before applying glue.



3) Apply glue to the root edge of the fin where it meets the motor tube and the body tube. Apply a heavy bead on the edge going into the slot. Apply a lighter bead on the edges that will join to the main body tube.

4) Insert the fin through the slot. Hold the fin against the motor tube and align the fin as straight as possible. Wipe away any excess glue from the surface of the body tube. Allow the glue to set before attaching the next fin.

5) Repeat for each of the three fins. Continue to check the alignment of all the fins until the glue has set. After glue has completely dried confirm that each fin is securely joined to the motor tube. If the fin is not bonded to the motor tube, it must be removed and re-glued.



6) Apply glue fillets to the joints between the body tube and each fin. Apply two fillets at a time. You can smooth out each fillet with a gloved finger to make a uniform joint. Keep the rocket horizontal with one fin pointed straight down until the two fillets are dry, then rotate the rocket and apply the next two fillets. Additional layers of glue may be added to reinforce the fillets and smooth out any dips.

Payload Section Assembly

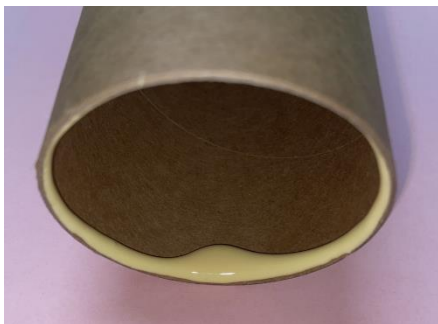
This section describes how to assemble the payload section. This section will slide onto the main body and hold your payload items (the altimeter and the egg).



1) Apply some glue to the hole in the bulkhead and screw the screw eye into the bulkhead.



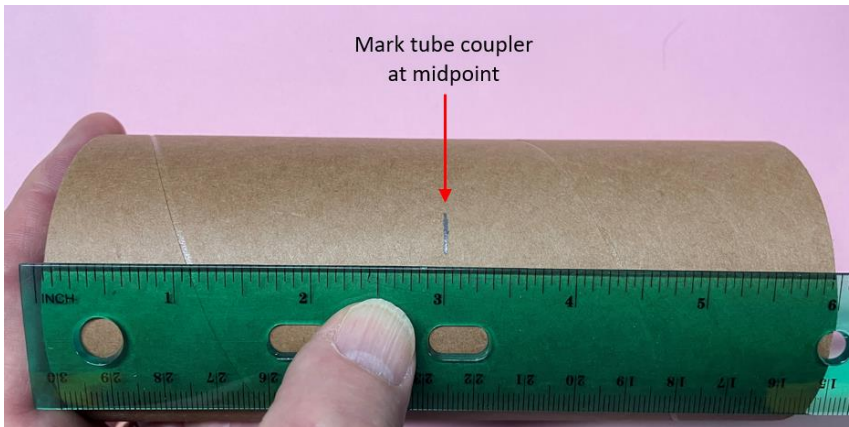
2) Apply a small amount of glue where the screw eye meets the bulkhead on both sides of the bulkhead. Let the glue set.



3) Apply a line of glue inside the end of the coupler. Insert the bulkhead ring into the coupler against the glue. Leave about 1/8-inch of the coupler showing at the bottom of the bulkhead. Position the coupler upright and allow glue to set.

Payload Design:

Your team is responsible for the design and construction of an inner structure of the payload section that will safely hold and protect the egg during flight and landing.



4) Mark the coupler at its half-way point (3" from the ends). Test fit the coupler tube into the payload tube to be sure it can be inserted easily. If necessary, sand the inside of the payload tube opening and the outside of the top edge of the coupler to allow coupler insertion.

5) Apply glue inside one end of the payload tube. Spread the glue evenly for a thin layer up to 3 inches inside the tube. Use a stick to spread the glue.



6) Insert the coupler into the end of the tube up to the half-way mark on the coupler. Make sure you do this quickly because the glue will set almost immediately! Position the assembly upright and allow the glue to dry.



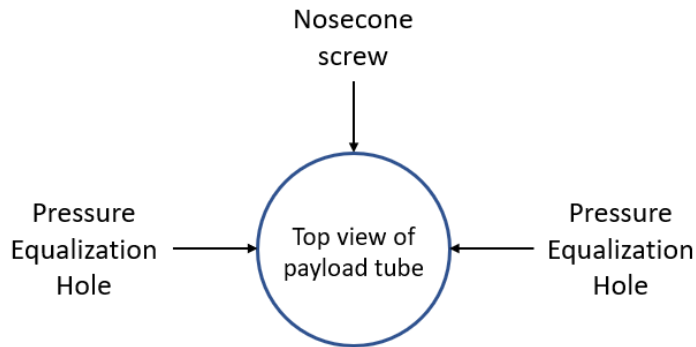
7) Apply a fillet of glue between the bottom of the bulkhead and the coupler. Allow glue to set.



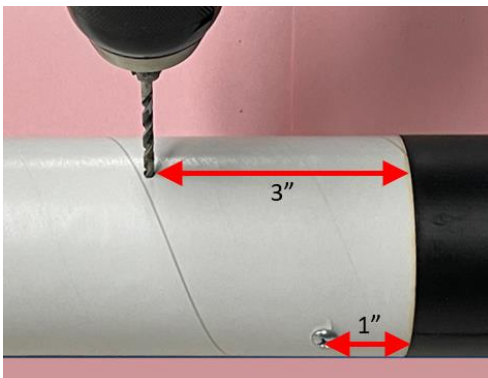
8) Mark a point 1 inch down from the top of the payload tube.

9) Fully insert the nosecone into the payload tube. Drill a 1/8-inch hole through the payload tube and nosecone shoulder at the 1-inch mark.

10) Install a wood screw in the hole to secure the nosecone to the payload tube. Do not overtighten the screw. Stop turning when the screw head touches the tube.



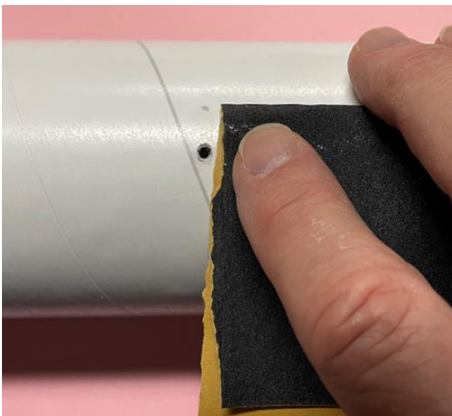
11) Mark two points, 3 inches down from the top to the payload tube, 90 degrees from the nosecone screw. These mark the location to drill two pressure equalization holes.



12) Drill a 1/8" pressure equalization hole at each of the two 3-inch marks.



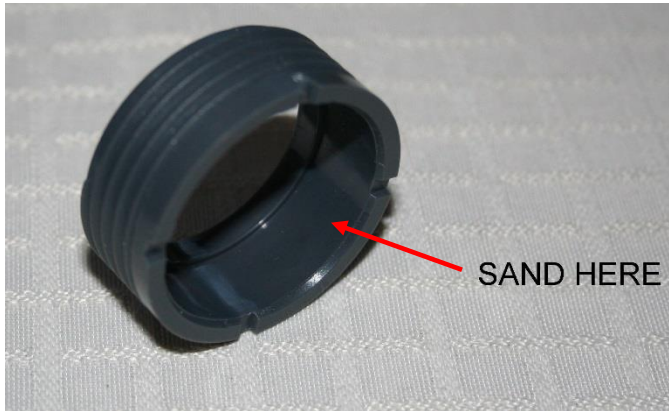
13) To avoid creating turbulence that may affect the altimeter reading, the pressure equalization holes should be smooth and square-edged. The hole left in the cardboard tube wall by the drill bit will be rough. To smooth the hole, start by placing a drop of thin CA glue in each hole and allow to dry. The rough cardboard edge will wick the CA glue and harden.



14) Sand the area around each hole with very fine sandpaper. Sand the outside of the payload tube and the inside of the tube. Run the 1/8" drill through each pressure equalization hole again and you will be left with square-edged holes.

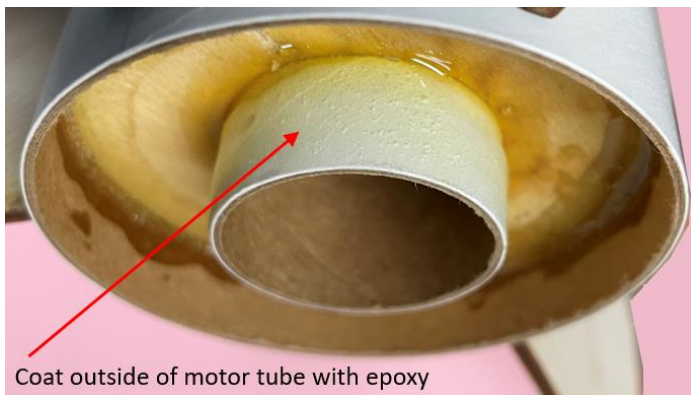
Plastic Motor Retainer

The inner ring of the plastic motor retainer is glued to the ½-inch length of motor tube extending below the lower centering ring.

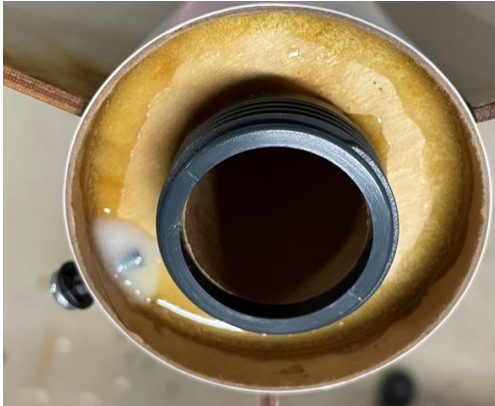


1) Lightly sand the outside of the 29 mm motor mount tube that protrudes from the aft end of the rocket. This will help the glue adhere to the tube.

2) Sand the inside surface of the motor retainer ring that will be glued to the motor tube. This is critical to achieve a strong joint.



3) Spread a thin layer of two-part 5-minute epoxy over the outside of the motor mount tube at the aft end of the rocket. **YOU MUST USE EPOXY FOR THIS STEP.** Always wear gloves when working with epoxy. Do not get any glue inside the motor tube.

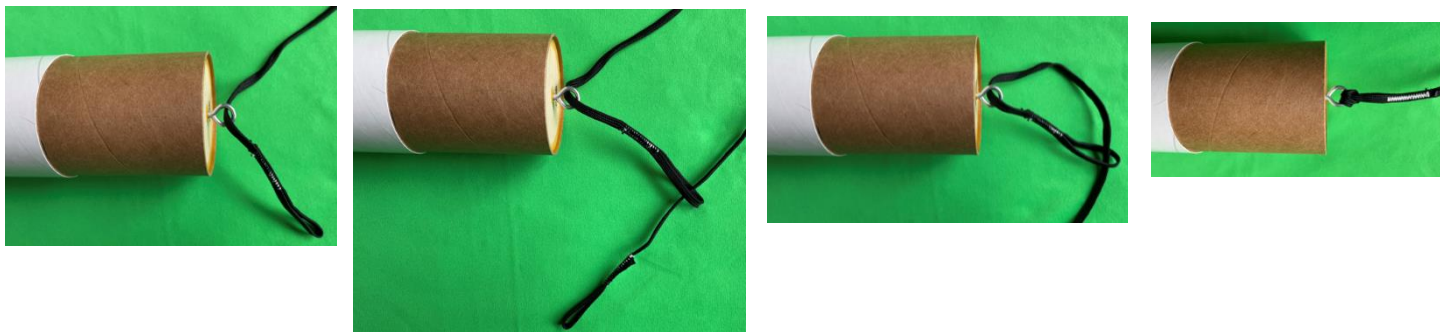


4) Press the motor retainer ring over the motor mount tube until it seats firmly on the motor tube. Wipe away any excess glue. Be careful not to get any glue on the retainer threads or inside the motor tube. If you do, wipe it off immediately before it sets.

Shock Cord and Parachute Final Assembly

The shock cord connects the main rocket body to the payload section. The parachute is attached to the shock cord. This section describes final assembly of these components. You can wait to attach the shock cord and parachute until after the rocket is painted if you want to paint the main body and payload sections separately.

1) Attach the nylon shock cord to the payload section screw eye by passing the loop at one end of the shock cord through the screw eye. Pass the other end of the shock cord through the loop and pull tight.



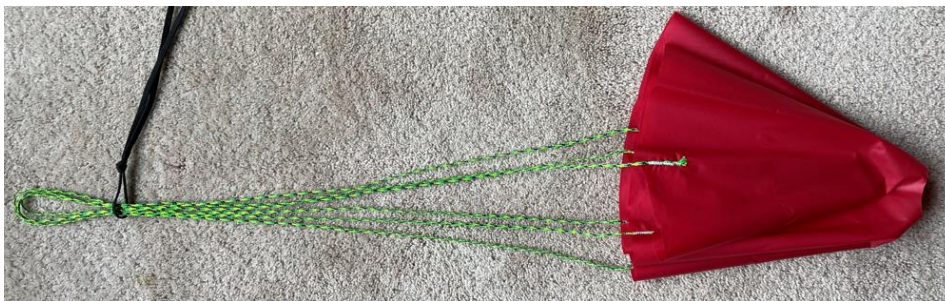
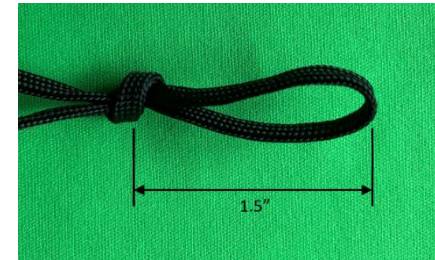
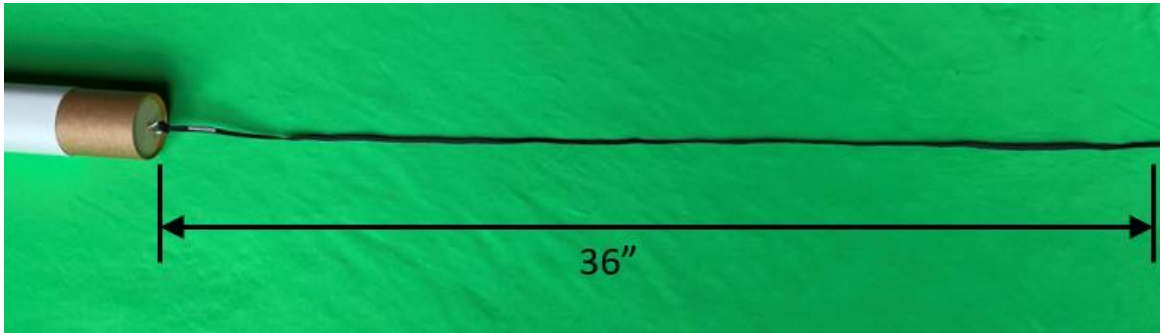
2) Pass the free end of the nylon shock cord through the buttonhole in the fire-resistant blanket. Pass the end through the buttonhole a second time.



3) Use a *follow-through figure eight loop knot* to attach the Kevlar shock cord mount to the loop in the free end of the nylon shock cord. See www.animatedknots.com/figure-8-follow-through-loop-knot for an animation of the knot. Secure the loose Kevlar end with several half hitches.



4) Measure 36 inches down from the nylon shock cord attachment point to the payload section (about 1/3 the length of the nylon shock cord) and tie an overhand loop knot. The loop should be about 1.5 inches long. This loop will be the parachute attachment point.

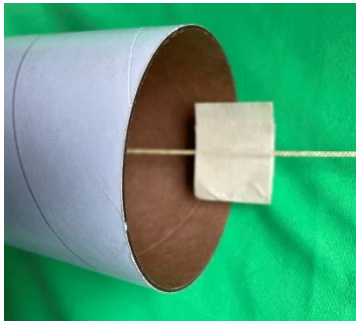


5) Pass the parachute shroud lines through parachute attachment loop.



6) Pass the parachute through the loop in the shroud lines and tighten.

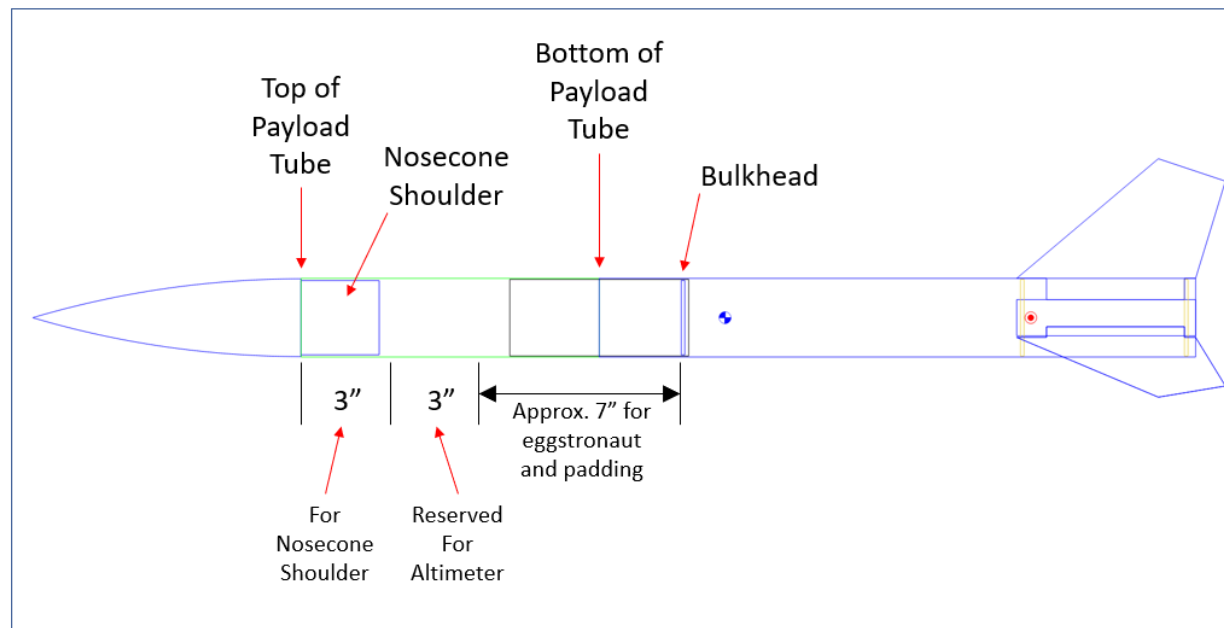




7) When the parachute ejects at apogee, the main body tube can be damaged by the thin Kevlar shock cord mount. The Kevlar cord can cut into the top of the body tube and tear a thin opening down the tube. This is called a zipper. The chance of zippering can be lessened by wrapping some masking tape around the Kevlar cord at a location that extends just above and below the top of the body tube.

Payload Section Preparation

You must design a system to protect your eggstronaut from damage during flight. The egg and its protection system will be located at the bottom of the payload compartment. The top of the payload compartment must be reserved for the nosecone shoulder and altimeter. The eggstronaut and its container must not extend above a point 6 inches below the top of the payload tube.



Securing the Altimeter

At the launch, the altimeter will be secured to the inside of the payload section within the reserved space. The MOST will provide an altimeter which will be secured within your payload section using Velcro. A $\frac{3}{4}$ -inch wide strip, 2- $\frac{1}{2}$ inches long, of hook side (the rough part) Velcro will be installed by event staff during altimeter installation. It will be placed vertically inside the reserve space of the payload section.

Stowing the Egg

The egg should be secured in the payload section in the area below the altimeter reserved space. It must be secure enough that it does not move and come in contact with the altimeter during flight. Your egg storage must be designed so that you can install the egg prior to launch, and remove it after recovery for inspection by the judges. Consider adding some type of handle that will allow you to remove the egg container without damage after flight. If you damage the egg upon removal, your eggstronaut recovery score will be negatively impacted.

Finishing Up!

Your rocket is almost ready to launch, but you will want to paint it first. Standard spray paints (such as Krylon) are low-cost and readily available at hardware and home improvement stores.

All surfaces should be sanded lightly before applying a primer coat. "Sandable primer" is recommended. Repeat the sanding and priming until you get a smooth surface.

Apply the final paint in light coats to prevent running. Your team may want to choose your school colors, and add lettering or decals of your own design. Laser printer decals are available at office supply stores. Airbrush painting is great for unique designs. Be creative!

Keep in mind that a rough finish (or other added stuff on the rocket!) will add drag. The drag forces will act against the thrust of the rocket motor, impacting the altitude of the rocket.

Be careful handling and storing your rocket!

The tube could be damaged easily if leaned against, or bounced around in your car!