**HEXA Rocket Documentation.**

**Intro**

Hey! First of all, thanks for your interest in HEXA! Whether you have bought a kit from my Tindie store or you are planning to make one from scratch, thanks!

This document is in a few sections, there is a bill of materials, some build instructions for the HEXA airframe and then some instructions to build the parachute kit that comes with the kit version. Towards the end of the document there are some notes for those wanting to create their own from scratch and some notes on flight/launch stuff.

**Bill of Materials (this is the list of kit parts, but is also what you would need to create)**

1 x 250mm cut and scored lower body tube section
1 x 100mm Cut and scored payload section
1 x PETG Coupler
1x PLA nosecone at 20% infill
1x base motor mount ring
1x internal centring ring
3x fins
1 x rail lug
1x elastic
1x elastic retaining card
1x parachute canopy

3x parachute shroud lines
6x vinyl parachute hole reinforcement rings
1x motor thrust ring (3 supplied in kit)

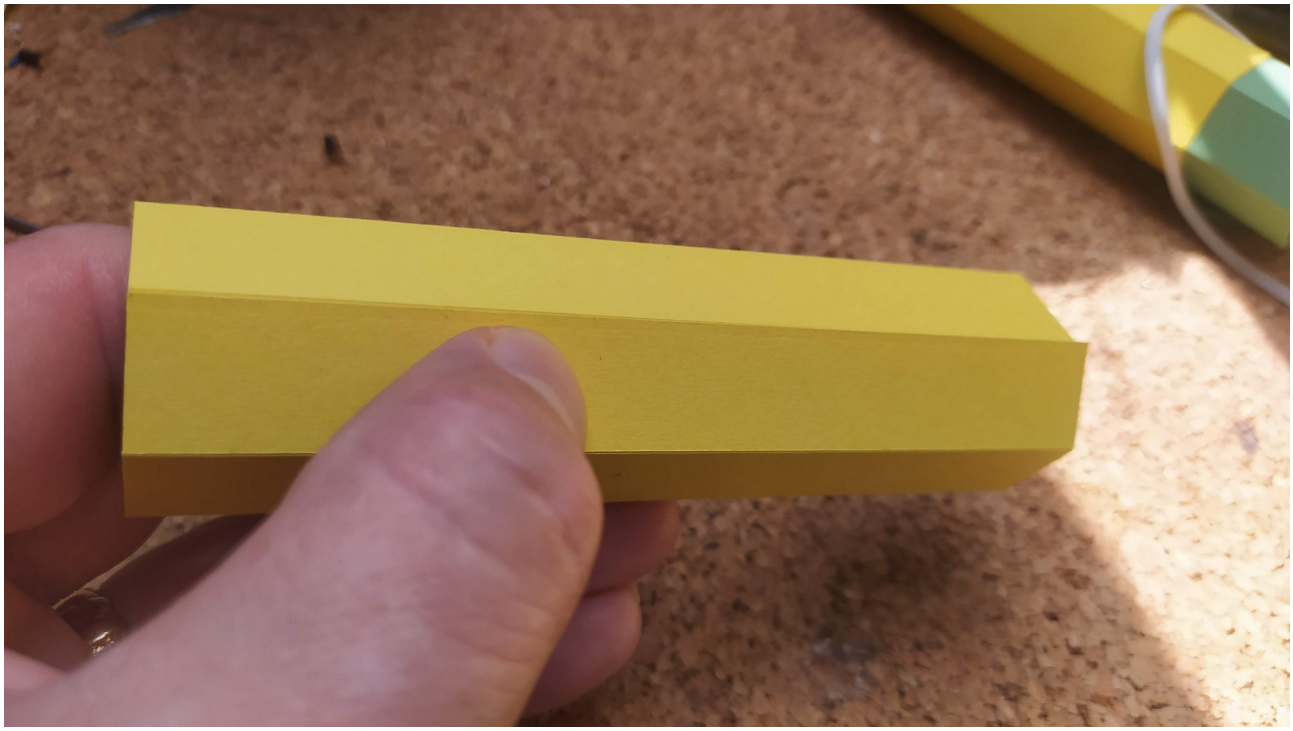
**Other Materials Needed**

Superglue
PVA glue

Optionally a glue stick/cocktail stick
Optionally some small rubber bands
Optionally sand paper and paints for finishing

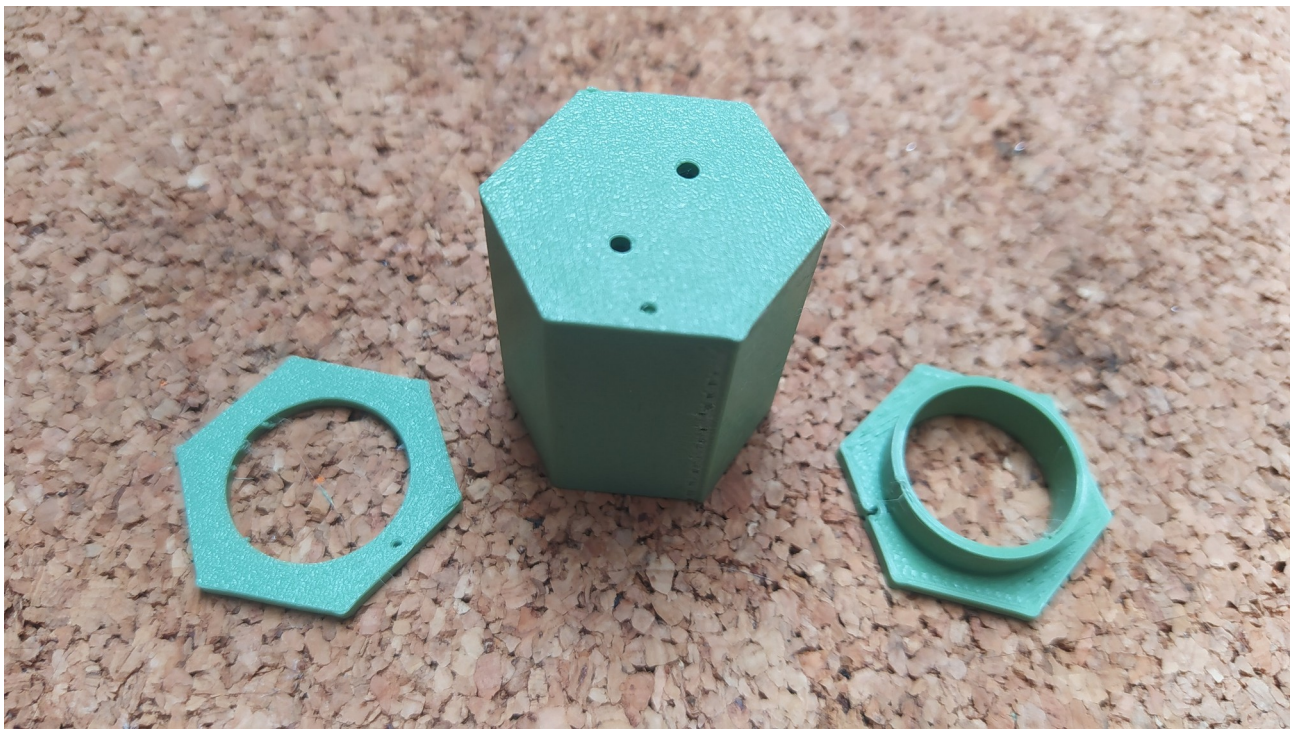
**Build Instructions**


First task is to assemble the hexagonal tubes. This is not too hard but probably the fiddliest job! Start with the payload section as this is easier than the longer lower body tube section. Before you attempt this use a ruler and measure the last scored strip on each side of the payload card and lower body tube card. Each side of the hexagon or each scored strip of the lower body tube card and payload section card are 15mm but one edge is a flap and is slightly smaller around 13mm. Identify which edge this is. This smaller edge flap is going to go INSIDE each tube.

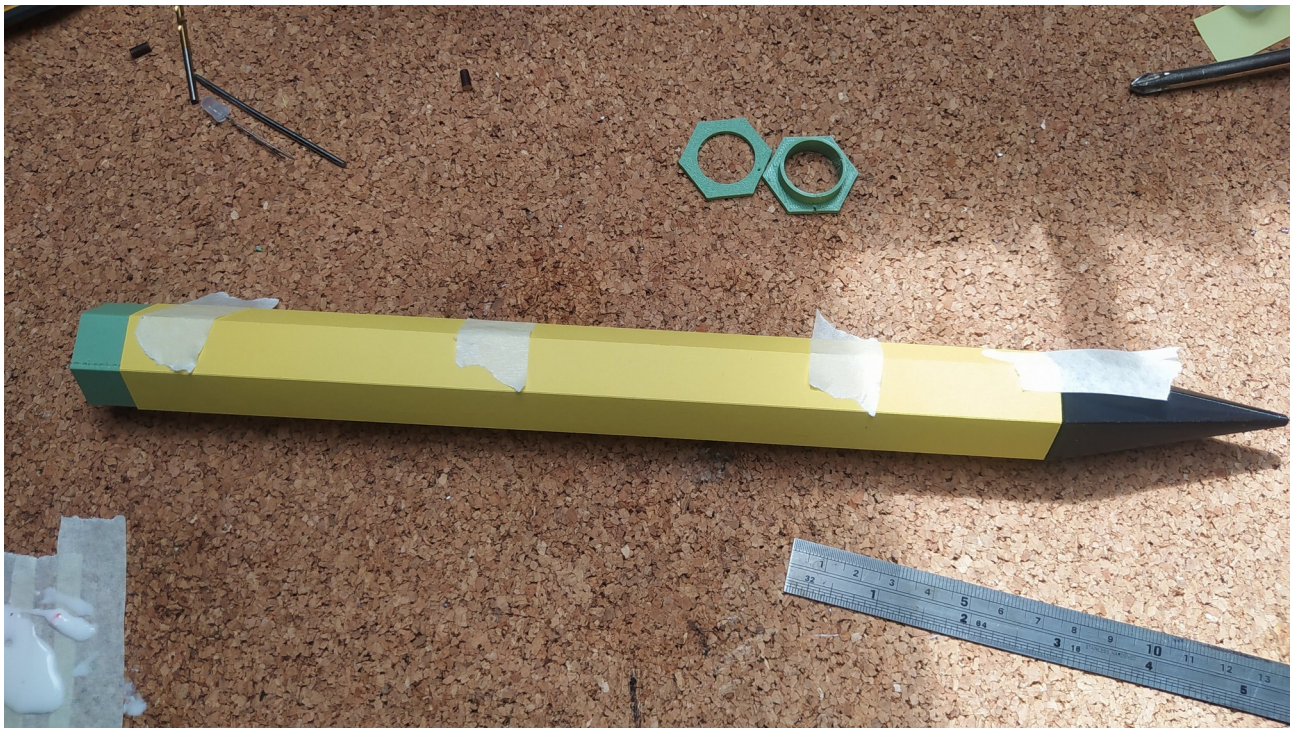


Gently fold each score line a little so that you can get the payload section card into a tube shape. Don’t worry if it doesn’t look like a perfect hexagon, when we add the coupler and the nosecone it will take it’s shape well. You want the upper and lower edges of the card to align well and the seam on the outside to be as flush to the hexagon corner as possible. Take your time and definitely have a few dry runs without glue at getting the payload tube into position.

You can complete the shorter payload tube just in your hands but as a practice you can fold the tube and insert the nosecone and the coupler WITHOUT GLUE and see how these can act as a jig to help assembly. When you feel confident add some PLA glue to the payload edge flap and glue the tube shut, alternatively a glue stick (Like Pritt stick (other makes available!)) can be used for a more even coat of glue.



**NOTE: In this kit all the hexagonal 3d printed parts have an orientation. Each part is marked with a dot/hole (on the nosecone its inside the coupler section) the marked edge is a little thinner to account for the double card layer forming the seam side of the hexagonal card tubes. Make sure this thinner edge is always aligned with that seam edge.**

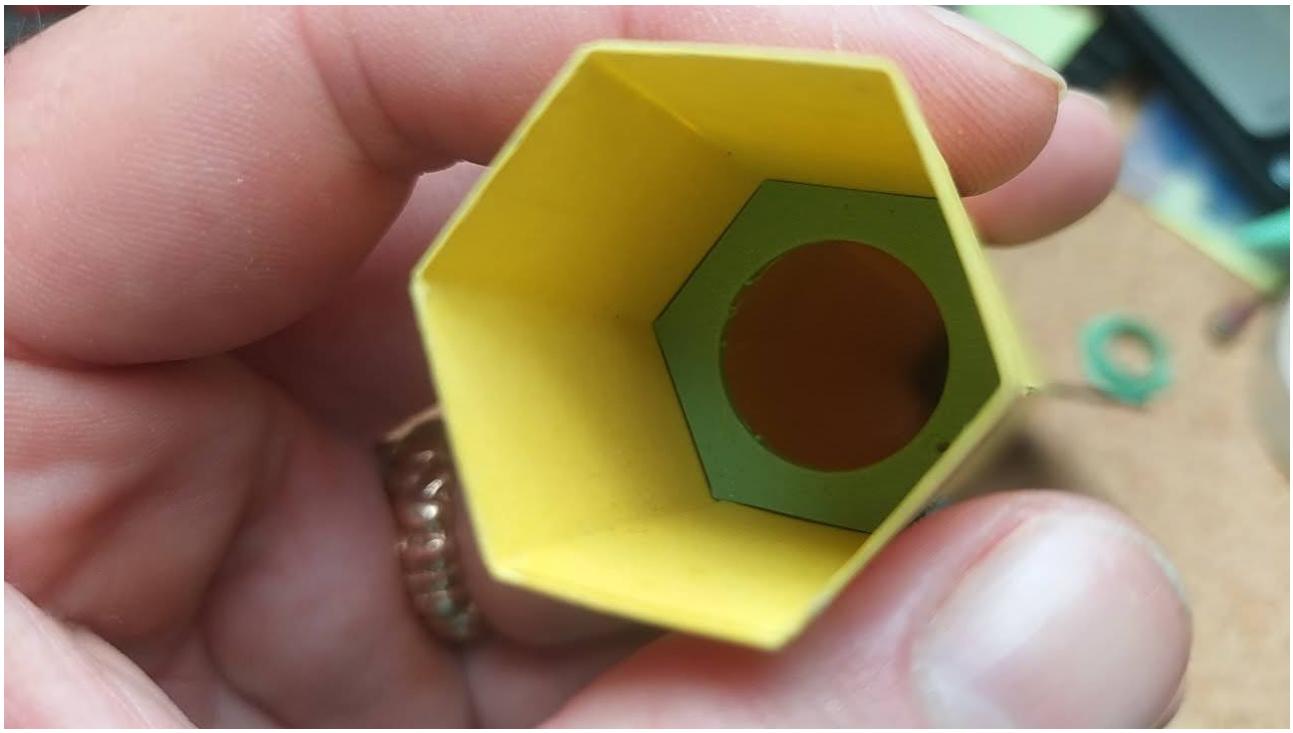


Moving to the lower body tube section, we've found these a little more tricky, it's exactly the same idea as the upper payload section but slightly more challenging as it's longer. Some tips we have found that help are: Hold the tube without glue roughly together and then insert the nosecone at one

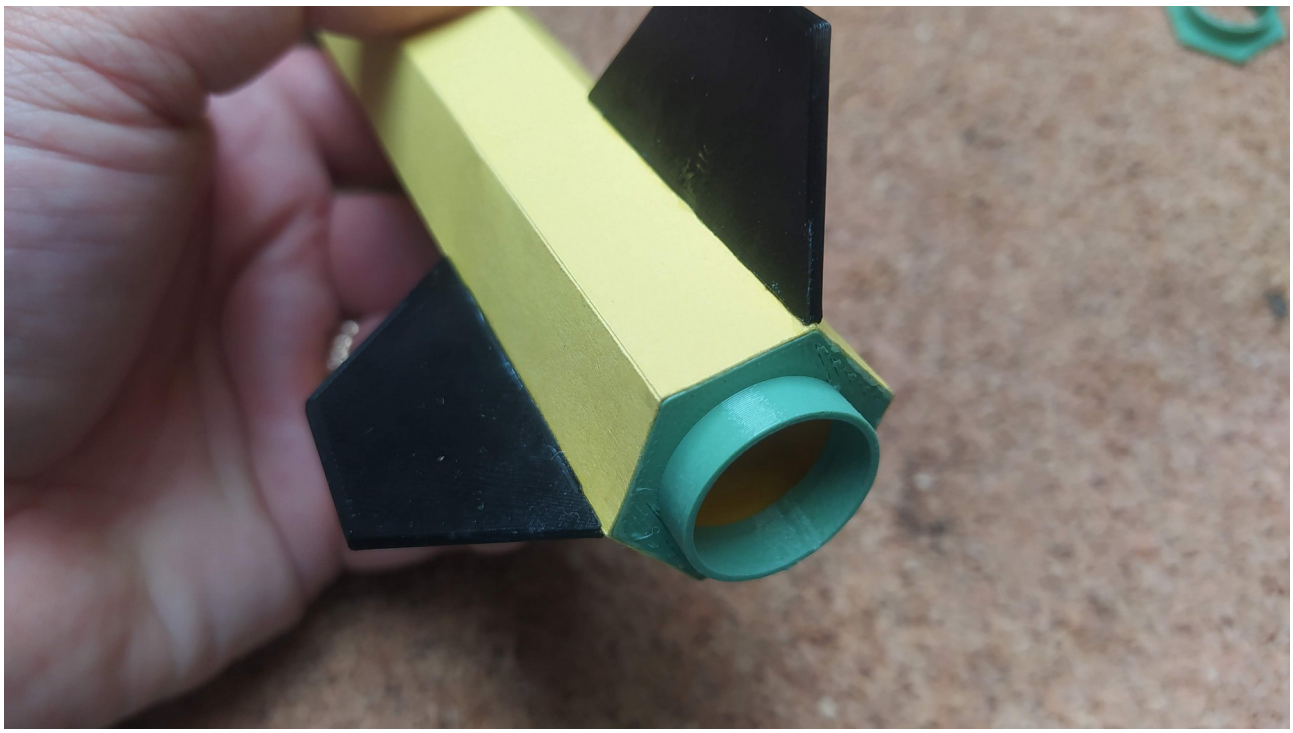
end and the coupler at the other **(noting the orientation of the 3d printed parts)**. You can then use some rubber bands to GENTLY hold the card tube in position over the nosecone coupler and the inserted coupler ends, again, DO NOT glue in the nosecone or the coupler!

You might notice that the tubes stick well at the ends but you need to press down the middle sections of the flap seams. Another tip is you can gently slide the coupler inside the tube to the area you need to press together and then use the coupler to press against.

Once you have the two tubes together the rest of the build is pretty straightforward.



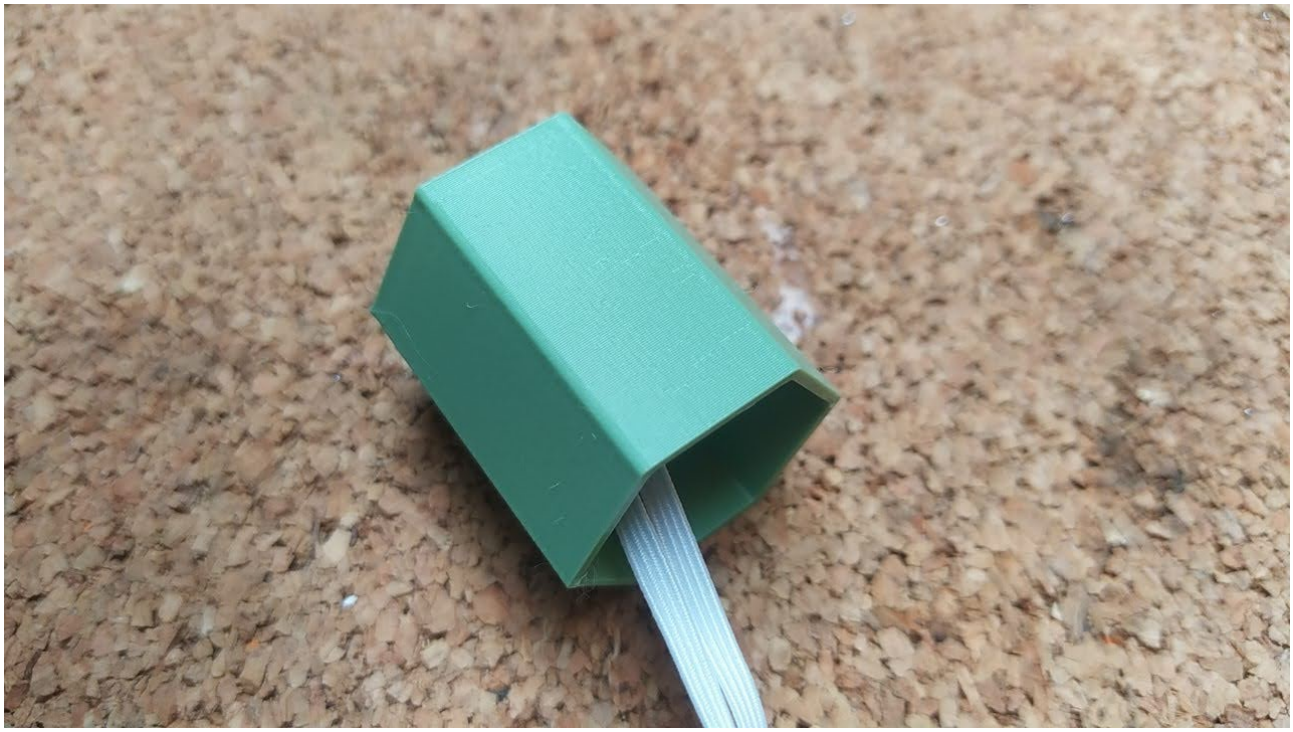
Taking the main lower body tube we need to insert the internal centring ring. We are going to glue this in 50mm down from one end of the tube, again, take note of the orientation, the side with the mark/hole should be against the double seamed side of the tube. Our best approach for this has been to take a small stick and mark it at 50mm. Gently ease the centring ring into the tube and push it down slowly towards 50mm, checking with the marked stick to see how deep it is, do this without glue! We have also used the coupler to help keep the centring ring absolutely square to the tube. Once you have the centring ring in position you can use a longer skewer to push the coupler back out of the tube using the large hole in the centring ring. Once you are happy with the placement of the centring ring use the marked stick to drop superglue around the perimeter of the centring ring against the cardboard tube. You may see that there are small gaps between the centring ring and the card tube, gently press from the outside to make sure the card is glued to the ring edges all the way around.



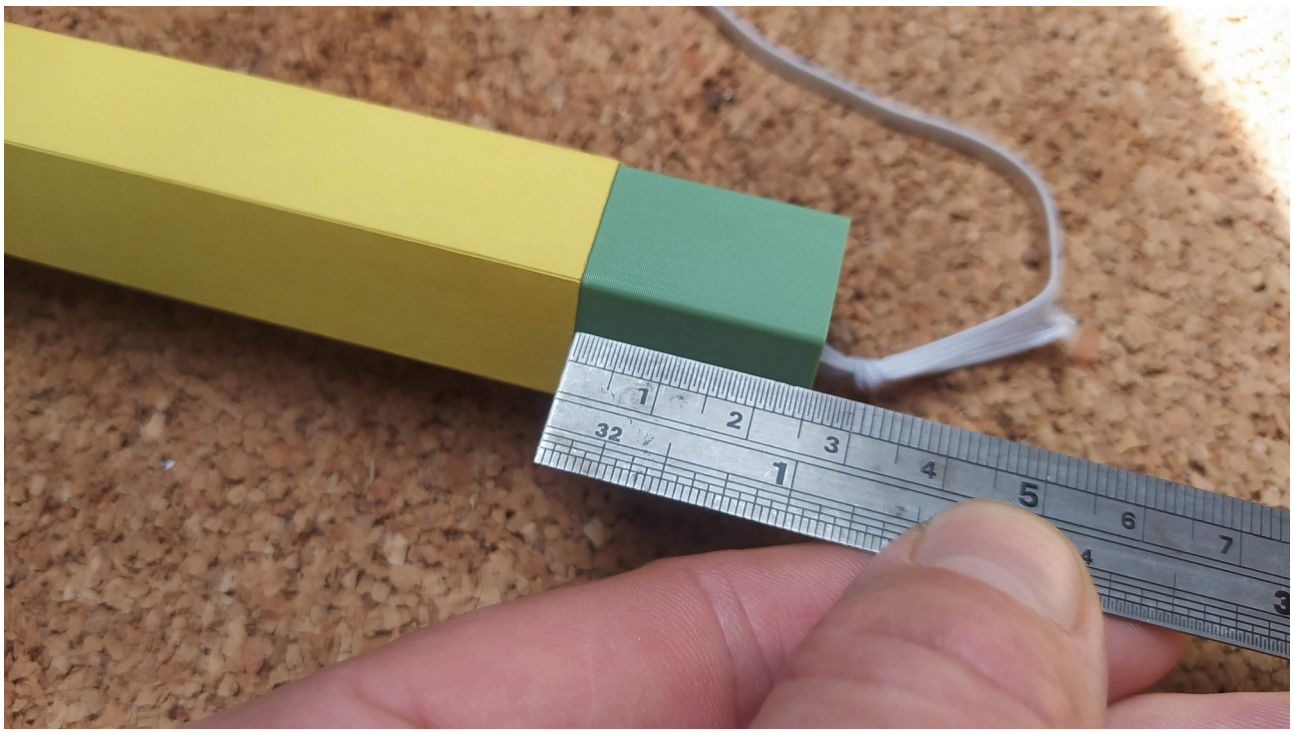
With that in place you next want to fit the motor mount ring into the same end where you fitted the centring ring. The motor mount ring will be glued into the very end of the tube with the edges if the tube sitting flush with the motor mount ring. Apply a small amount of superglue around the inside of the tube end and fit the motor mount.

Fitting the fins to the lower body tube is pretty straightforward. If you have a kit version the fins will have small “helper discs” printed onto the ends that will need trimming off with a craft knife. In 3D printing very sharp angles such as the ends of these fins are hard to print as they often warp away from the printer bed, adding these easily trimmed discs allows them to print well. Trim the discs away and clean up the edges of the fins. The fins are easy to fit as they have a 120 degree v slot in the root edge which conforms to the body tube edges perfectly and you can easily fit these without any jig. Use some superglue in the V slot and then place the fin on the cardboard tube with the trailing edge of the fin flush with the bottom of the tube. Visually check the fin is aligned and vertical and hold for a few moments to set. Repeat this with the other fins, making sure you leave

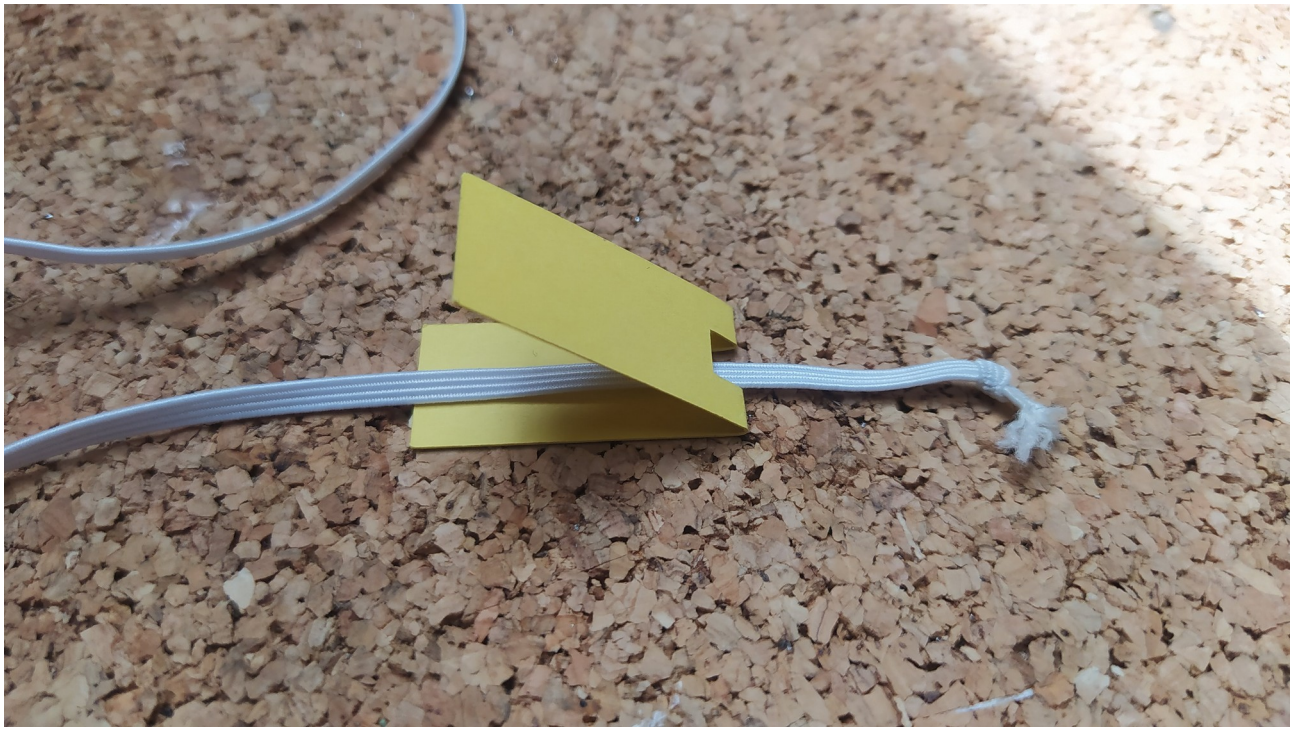
one hexagon edge clear in between each fin. With the fins glued on with superglue and optional idea is to build up some small fillet layers of PVA glue between the card and the fin. This classic model rocket technique, adds some strength and smooths out that joint improving airflow.



Moving to the payload section we need to glue the coupler into the tube. It’s easier to fit the elastic into the coupler before the payload area is assembled (in the kit the elastic is in the small bag containing the parachute/recovery parts). Use a cocktail stick, a pin or some other small pointed object to push the 3mm elastic through one of the holes and back down through the other. The coupler is designed for the open end to face back down into the lower body tube section. With a short section of elastic pulled through the coupler tie a knot to join the elastic ends together in a loop.

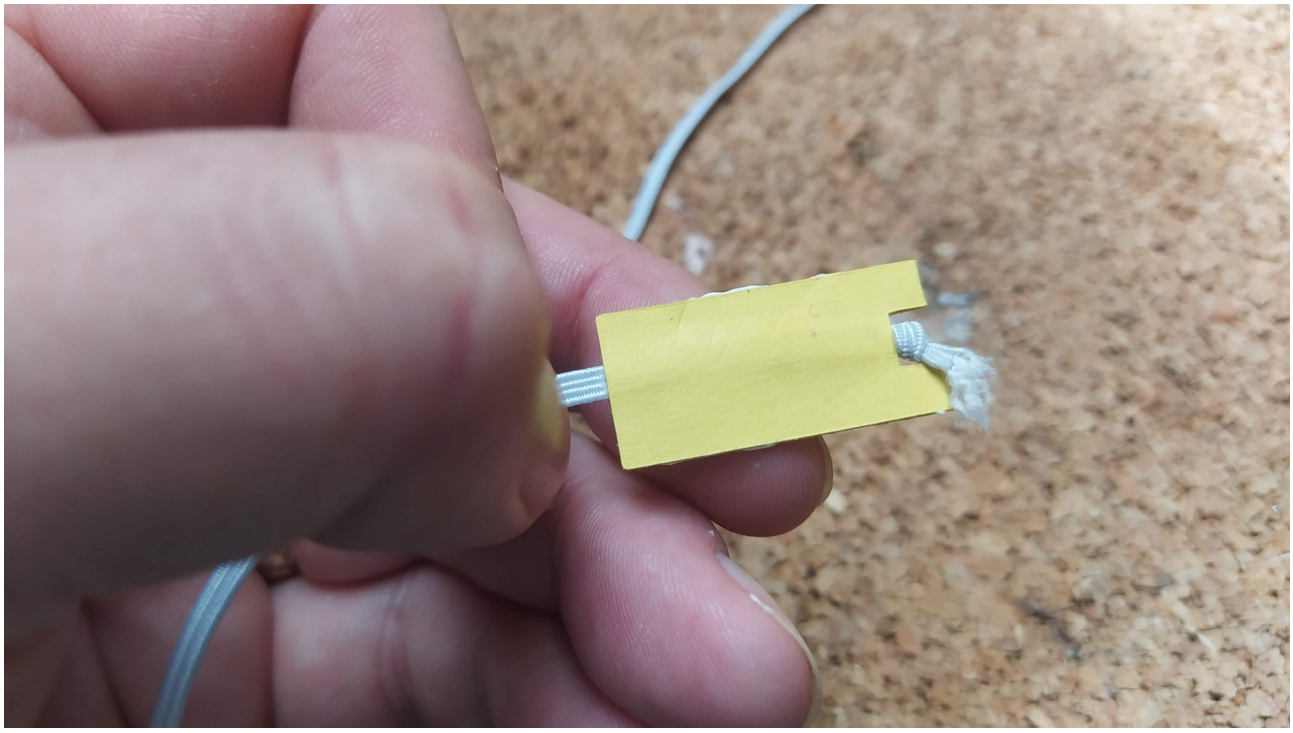


We need to glue the coupler 5mm into the payload tube. To do this you can use a ruler and mark the sides of the coupler 5mm down from the bulkhead end. Then add a little superglue to the inside of the payload tube and, remembering to check the orientation mark on the coupler, insert the coupler to the 5mm depth.



To attach the other end of the elastic into the main lower body tube section take the small elastic retainer card part and fold it exactly in half. That should then leave a small hole at one end. Take your elastic and place it through the hole in the retainer card. Tie a simple overhand knot in the end of the elastic. Next, inside the folded retainer card, place a decent amount of PVA glue. Then

squeeze the card together with the elastic running down the centre of the card and the knot just inside the hole. Leave this to dry occasionally checking and squeezing it together.

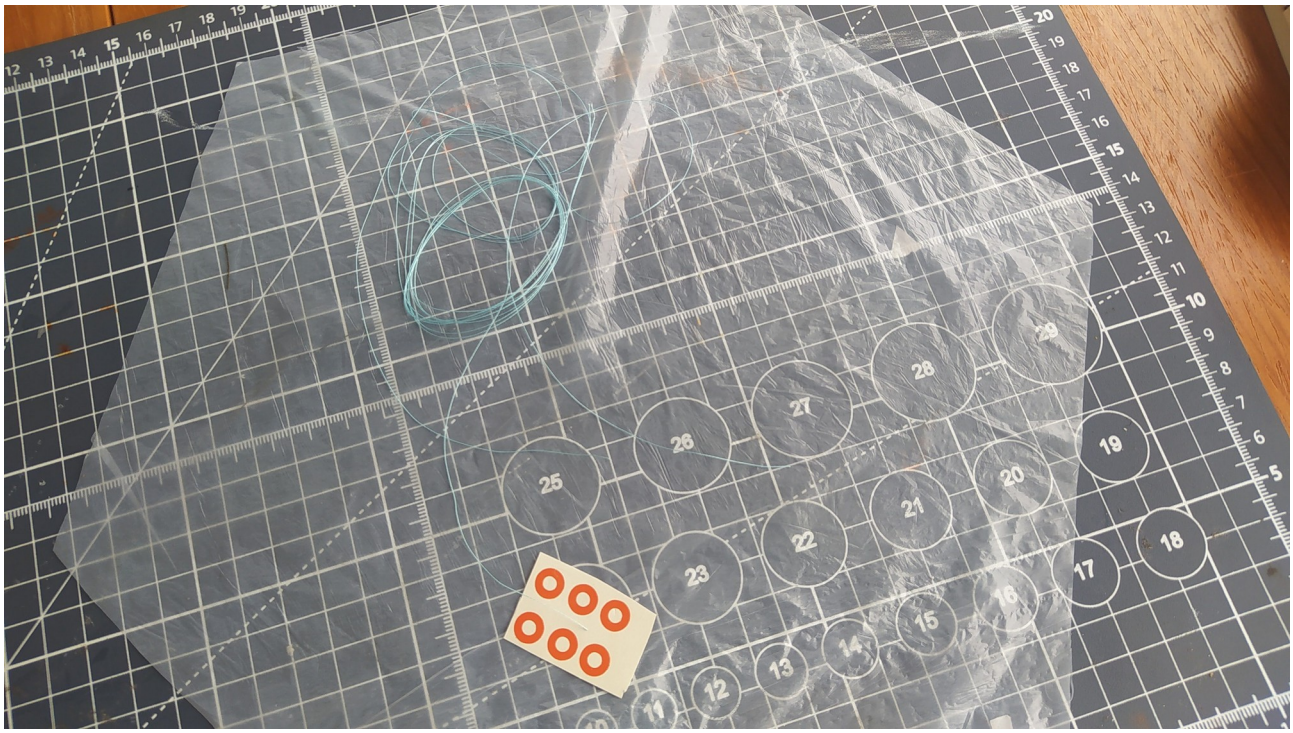


Once the retainer card area is dry you then need to add PVA glue to one side of the card and insert it into the main lower body tube and stick it flush to a side wall. **NOTE; THIS MUST BE INSIDE THE TUBE DEEP ENOUGH THAT THE COUPLER FROM THE PAYLOAD CAN STILL SLIDE IN.** This part needs to be attached well, but don't put too much glue on as the PVA moisture might warp your body tube. We've found it best to glue it into place with a light layer of glue and then reinforce the device by adding thin layers of glue to the edges of the elastic retainer once installed.

Finally we need to stick the rail lug device onto the rocket body. This again has a conformal slot to allow it to be easily superglued on to an edge of the hexagonal lower body tube. We've tended to place these rail lug assemblies around 15mm from the upper edge of the lower body section. Of course, if you have a larger launch rail or want to mount a different launch lug or conformal button you are free to experiment. **Make sure that you mount the launch lug in between two fins! Not on the same edge as a fin or it won't work!**

You can now test fit all the sections together, you might need to add small sections of tape to the outside edge of the coupler to adjust the coupler to a sliding fit. You want the payload section to be blown off easily but not fall out prematurely. If you have built, or had the opportunity to handle a built small rocket kit like and Estes etc you can gauge what this fit should be. The nosecone can similarly be held in by friction or you can use tape on the outside to hold it in place. The nosecone actually have a small tunnel for a string/elastic printed into them so there are experimental options if you wanted to do a miniature dual deploy hexagonal rocket!

**Parachute Assembly**

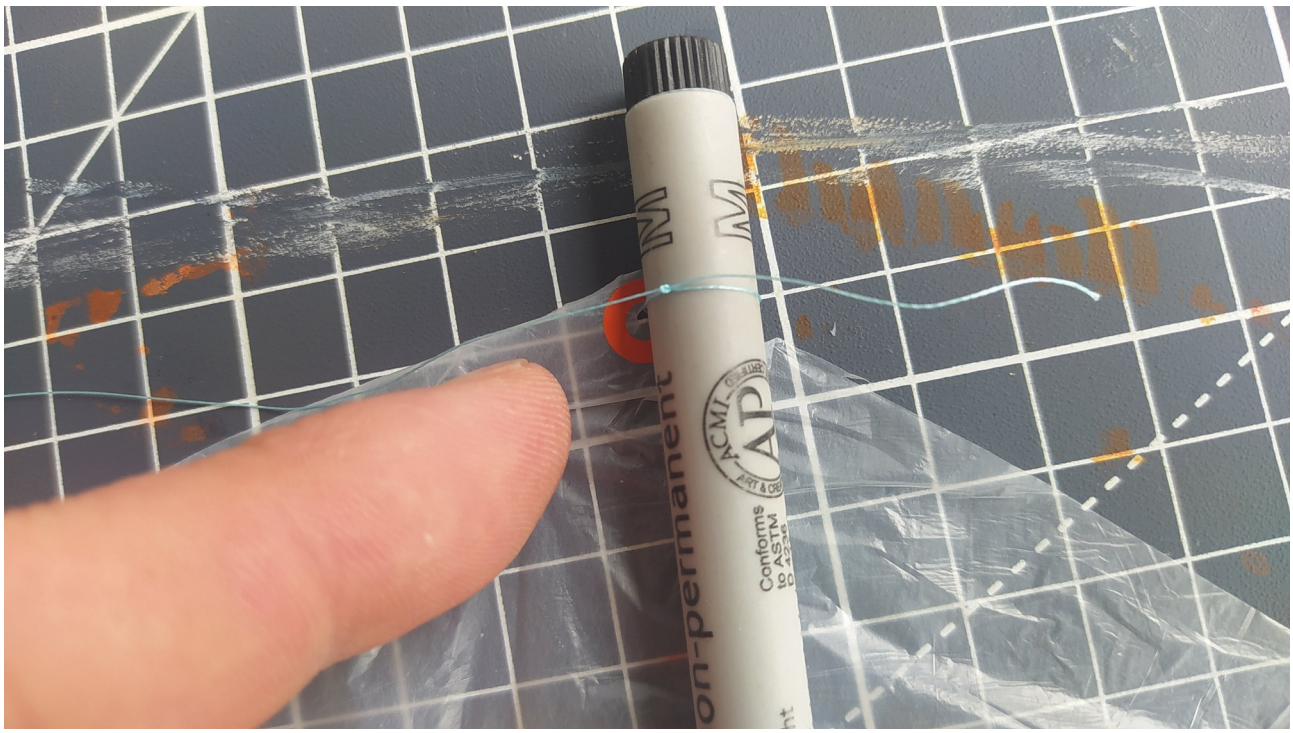


Assembling the parachute is pretty straightforward. If you have a kit then you can spread the lightweight canopy plastic out flat on a work surface.

Next place one of the self adhesive vinyl reinforcement rings in each corner of the hexagonal canopy sheet.

Next take a pin/needle (or at a push a ball point pen!) and make small holes inside each of the vinyl reinforcement rings.

The fine braided line in the HEXA kits is a 6lb fishing line cut to length (84cm). To tie it into position it can be useful to have an object to tie the knot around rather than pulling/cinching the canopy fabric. Our approach is to place the end of the braided line through the hole in the canopy and then tie a reef knot over the top of a pen that is about 8mm diameter. This then allows you to pull the knot tight but leave a loop to allow the canopy to open correctly. With your first knot tied tie the other end of the same line into the opposite corner of the hexagonal canopy using the same method. Take care to try and use exactly the same amount of braided line for each knot so that each line “pair” is the same size, aim to only have around 15mm of spare end on the dead end of the tied knot. Of course you can trim the dead end back to a couple of mm when you are sure everything is tied correctly. With the three shroud lines added collect the lines together at the centre point and pull the parachute through the air by hand to make sure it inflates correctly.

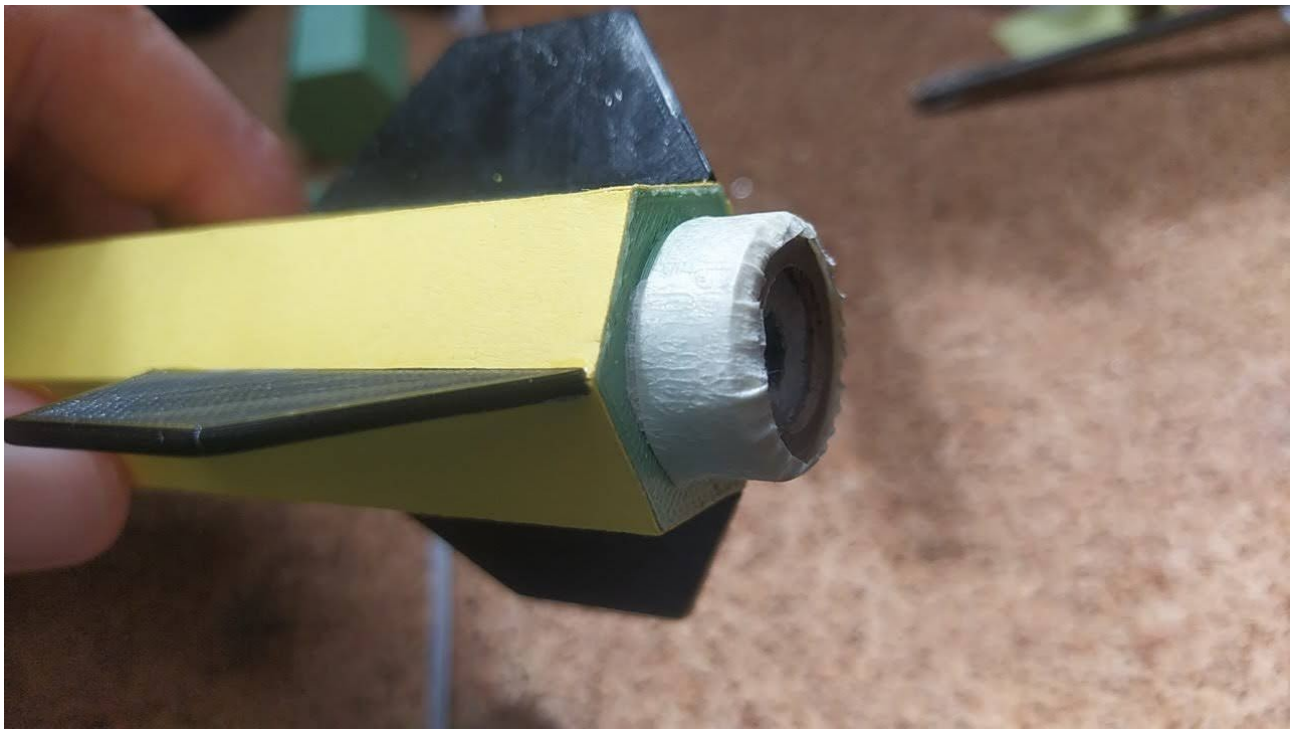



There are lots of ways people choose to attach parachutes into small rockets. The simplest method we have used successfully on this design is to tie a small loop in the elastic a few centimetres below the coupler and then pass the shroud line centres through that loop, then pass the parachute through the shroud lines and pulling it tight to create a “larks foot” knot.

**Assembling a motor for flight.**


The HEXA can be flown on a variety of motors but has mostly been test flown using Estes B6-4 motors which work very well. We are using an external thrust ring added to our 18mm motor so we

need to prepare this before a flight. In the kit you should find 3 motor thrust rings, which are single use. Take one of the motor thrust rings and glue it to the nozzle end of an 18mm motor with some super glue and make sure to allow it to dry fully before inserting it into any rocket! If you don't have any of the printed rings it's a long standing technique that you can make a small thrust ring on a motor using superglue and masking tape. Cut a small strip say 2mm wide from a length of masking tape and carefully wrap multiple layers around the base of the motor to create a small ring. Reinforce this ring by soaking in a small amount of superglue, again, ensure this is fully dry before placing it in a rocket!



To stop the motor ejecting from the rocket we can use a small length of masking tape wrapped around the motor mount tube attached to the rocket and the motor thrust ring we have glued to the motor. If you have small amounts of tape higher than the motor you can fold these over the ends of the motor tube, but obviously don't tape over the motor nozzle!

**Notes on Flying**

If all has gone well you should end up with a HEXA that weighs around 65grams or a little less. If you have built a kit version the nosecones are printed in PLA at a 20% infill and this, without any items/mass in the payload tube will set the centre of gravity at around 10cm back from the payload/lower body tube joint. If you add small payload objects then the design will become more stable. If you are making one from scratch/printing yourself then you can print 5% or 0% infill nosecones to keep the centre of gravity in the correct position whilst maximising performance.

For flights the launch lug has a 4mm hole so is designed for a standard small 1/8" Estes launch rail. You'll need to add a small piece of wadding about the size of a single Estes wadding sheet.

All test flights so far have been with Estes B6-4 motors and it's performed really well. The maximum lift off weight cited by Estes for a B6-4 is 113 grams so if you wanted to add paint and payload to the HEXA design then you have plenty of headroom.

It hasn't flown with an altimeter on board yet but a visual estimation of a B6-4 is around 500-550ft or 175m.

**Notes for self build/print**

Really interested and hope to see people printing their own HEXA!

**Creating tubes**

I use a small vinyl cutter to cut and score the card components for the tubes, and for the recovery retainer card pad. It's totally possible though to hand cut and score the designs. The inkscape files for the cut rectangle and the score lines may well appear blank when you open them as I tend to work in "outline view" where the drawn paths are outlines with no pen stroke on them. You can select all the paths in a document and then add a "stroke" using the fill and stroke menu to add a line for printing.

For the tube sections in the kits I use a standard 220gsm A4 cardstock.

**3D printed parts**

So for the prototypes, including first flight prototypes, of HEXA everything was printed in PLA. This was absolutely fine and they flew multiple times with no problems. For the kit version the decision was made to make all parts that come into contact more than once with motors and ejection gas out of PETG to be more resilient over time. So the motor mount rings and the coupler. Everything else in the kit is PLA. In reality, it's fine to print the entire thing out of PLA.

The nosecones I tend to print upright with some custom supports painted into the inside of the coupler section of the nosecone.

If you are scratch building it can be really useful to print a spare coupler to use as an extra jig for assembling the lower body tube, not essential but it can act as an extra internal support structure whilst glueing the tube.

**Parachute**

The basic parachute I have described above can be made with a 30cm major axis hexagon cut from a lightweight waste bag (cheap pedal bin liner etc!).