Apogee Components

PEAK OF FLIGHT

NEWSLETTER

Build Yourself A Great Rocket For Your Science Fair Experiment

EMRR Corner

Reader Questions About Cluster Motor Rockets

Cover Photo: Quasar One's "Fox Tango 7." To get one, visit:
www.ApogeeRockets.com/quasar_fox_tango.asp

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Build a Great Science Fair Rocket

By Tim Van Milligan

If you're a science experimenter, or if you are mentoring one, then you may need a good test-vehicle rocket for your science fair project. In this article, I thought I'd give you some ideas for one such rocket.

One of the most popular experiments that I see people doing year-in and year-out is to find out which shape nose cone is most efficient. I'm beginning to wonder if anyone has seen the other 68 projects in my science fair book called "69 Simple Science Fair Projects with Model Rockets: Aeronautics." But it is a good project.

Just last week, I got this email from Tim Kreps, a rocketeer in Maryland. He writes *"I just did an experiment with my son (age 12, grade 5) and some students from his science class on 'the cause and effect of a rocket altitude based by different nose cone shapes'. We built a mid-range rocket (and a backup) and fired the rocket 12 times (3 times each per nose cone type) to get an average altitude per nose cone for a total of four different nose cones. We used the same rocket and engine type for each flight. A very successful experiment; rocket performed flawlessly. The boys collected data by taking altitude readings (the hard way), positioning themselves 500 feet from the rocket and taking angle readings, converting the angle to their tangent and producing a logarithmic chart in Excel to product their findings for each nose cone type."*

It is a good project because it works. But as Tim Kreps implied in his note, there is a hard way to do it. If that is true, what is the easy way? Obviously, it is to use an electronic altimeter (www.apogeerockets.com/altimeter.asp) to measure how high the rocket flew and avoid doing optical tracking. These devices are very accurate and easy to use. It is almost as simple as turning it on and dropping it into your rocket. When you get the unit back, it tells you how high the rocket flew.

The drawback, of course, is the price. I wouldn't want to lose one, and I definitely don't want to do anything stupid to damage it. The best way to protect it is to mount it in a payload bay of a rocket. If you don't do this, it is going to get toasted by the intense heat of the rocket motor's ejection charge.

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Figure 1: The Avion rocket can easily be upgraded to carry an altimeter payload and be used as a science fair rocket to study aerodynamics. A popular experiment is to see which nose cone shape is most efficient.

About this Newsletter

You can subscribe to receive this e-zine FREE at the Apogee Components web site (www.ApogeeRockets.com), or by sending an e-mail to: ezine@apogeeRockets.com with "SUBSCRIBE" as the subject line of the message.

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Mounting the altimeter in the payload bay is pretty easy. In fact, if you've been following Apogee Components' "how-to" videos, I showed you several things related to payload rockets.

How to mount an altimeter into a small diameter payload bay (www.apogeerockets.com/Rocketry_Videos/Rocketry_Video_04.asp)

How to make a payload bay for a rocket (www.apogeerockets.com/Rocketry_Videos/Rocketry_Video_09.asp)

And finally, how to make a tube coupler, which you will need to use as a shoulder for the rear end of a payload bay tube (www.apogeerockets.com/Rocketry_Videos/Rocketry_Video_08.asp)

With these videos, you're about 90% complete to having a good rocket that you can use for science fair projects, such as the experiment to see which nose cone is the most efficient.

There is one little problem you need to solve in order to make the perfect science fair project workhorse rocket. Let me explain.

One of the objectives of science fair projects is to teach the scientific method. That is, you only test one variable at a time. When doing the experiment with the nose cone shapes, there is a second variable that you have to neutralize: the differing weights of the nose cones.

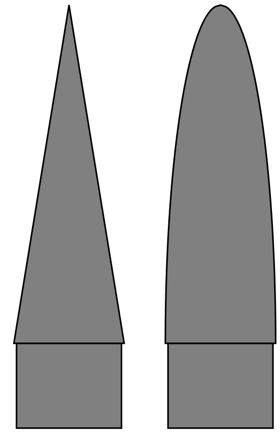

Figure 2: Different shapes will have different masses.

Because the nose cones have different shapes, they have different internal volume. If you multiply an object's volume by the material density, you get the object's weight. Even if the density of the nose cone material is the same, because you have different internal volume, they will all have different mass.

So what are you going to do to make sure all your experimental rockets weigh the same when you go to launch them? That's easy. You add weight to the light-weight ones so that they come up to the weight of the heaviest rocket.

Here's what you do. We'll use the nose cone experiment as the example. When you get your nose cones, the first thing you'd do is to put them, one-at-a-time, on a scale and write down what each one weighs. After weighing them, I'd arrange them by heaviest to lightest.

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The task at hand is to add weight to the lighter nose cones so that they all equal the hefty one.

You could simply add washers or clay to the nose cones, and that does work. But it never fails, right before you go to launch the rockets, you find that the weight of the heavy rocket changed. Maybe you had to add some tape to the shoulder to tighten up the fit so that the nose doesn't fall off during the flight. Or maybe the motor you put in the rocket is slightly heavier than the rest of the motors in the test batch. Regardless, you now have a situation where you have to adjust the weight of all the nose cones all over again.

Fortunately, there are two ways to "easily" account for the differing weights. And you can adjust them right before you put the rocket on the pad for launch. Hint: a portable battery powered scale that you can take to the range will come in really handy.

The first way is to use tracking powder, and simply pour it into the tube after you've inserted the wadding.

What is tracking powder? It is any non-flammable powdery substance that you can put into the rocket that when ejected will create a puffy cloud in the sky. This helps you to find the rocket, since a large cloud is easier to spot in the sky than a tiny rocket. Talcum powder works great, as does dry tempura paint and ground chalk. I personally prefer chalk, because you can get it in several colors.

Using tracking powder can be a bit messy and tricky. If you don't do it right, you can easily clog the tube and then the parachute won't eject at the apogee point. For tips on using tracking powder, see Newsletter 10 (www.ApogeeRockets.com/Education/Downloads/Newsletter10.pdf)

Just be careful when using tracking powder if you are flying an altimeter in your rocket. I wouldn't want you to get a no-deploy and then see the rocket lawn-dart into the ground and destroy that expensive altimeter.

The other option is to put ballast weight into the payload bay of the rocket, instead of in the main body tube where the parachute is stowed. The advantage of this is that it is cleaner (no messy powder all over your hands or rocket), and it doesn't interfere with the parachute coming out of the tube at ejection. The one disadvantage is you don't have the benefit of a colorful cloud in the sky to help you track the rocket if it flies too high.

What can you use for ballast? Great question. Because the weight differences between the rockets may be small, you need something that will allow you to get precise. The same substances you may use for tracking powder could work. But I prefer something a bit more gritty, like sand.

Sand works well, because it isn't nearly as messy as powdery substances like talcum powder.

Obviously, you can't put it into the same payload bay as the one holding the altimeter. You wouldn't want to plug up the tiny pressure sensor with a grain of sand.

The solution is to divide the payload tube with a solid bulkhead so that you can put the altimeter in one section,

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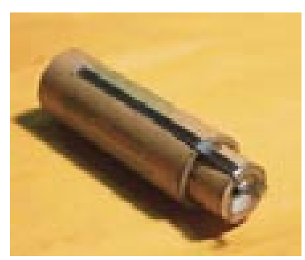
Low Cost Adapters for Low Power Motors

As found on EMRR, contributed by Scott Turnbull: This article describes some low cost, do it yourself options for putting smaller motors in upsized motor mounts. For example, to use an 18mm motor in a 24mm mount, an adapter can be fashioned from a used 24mm motor. An 18mm casing fits snugly inside a 24mm casing.

Using a razor knife cut a slot in the outside of the 24mm casing. Cut a narrow slit all the way through the casing at the forward end of the slot to accommodate the forward hook of a motor retention clip. Cut the slot so that a standard motor clip fits flush into the slot. The 24mm casing, with its flush mounted clip, can be loaded with a 18mm motor and inserted into a standard 24mm mount. You can also use a section of 18mm casing as a thrust ring glued inside the 24mm casing. Make sure the forward end of the adapter has a hole for allowing ejection gasses to enter the airframe.

A similar technique can be used for 13mm motors (into an 18mm casing), and 24mm motors (into a single-use 29mm Econoject casing with a sleeve).

These are all described in the complete Featured Tip on EMRR.



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and the sand in the other. Pretty simple, huh? I like simple solutions.

Here are some step-by-step instructions for making the modification to the payload tube.

Step 1. Size the payload tube so that its length will give you room for both the altimeter and the ballast compartment. Just lay everything out so that you can make the front-to-back measurement. This includes the aft coupler-bulkhead, the altimeter, the bulkhead between the two compartments, the length of the ballast compartment (I suggest 1/2 inch long), and finally, the shoulder on the base of the nose cone.

Step 2: It can be tricky to get the separating bulkhead disk (a thick piece of cardstock works great) into the tube and perpendicular to the sides of the tube. What I suggest is to glue the disk to a centering ring that fits inside the tube. The ring will keep the disk nice and flat as you slide it into the tube.

Figure 4: After gluing the ring to a piece of cardstock, cut around the perimeter with a hobby knife.

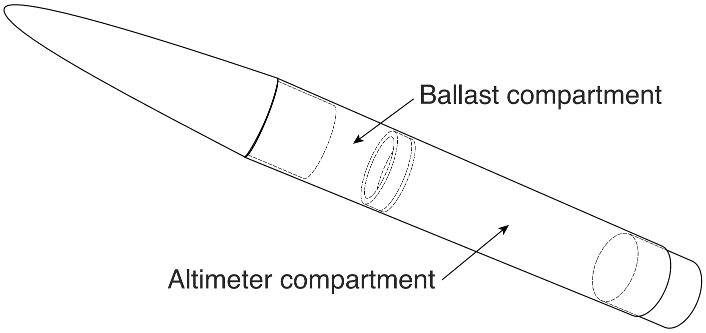

Figure 3: Size the payload tube to leave room for both the ballast and the altimeter.

I found it is easy to make the bulkhead by first gluing the ring to a slab of cardstock, and then cutting around the edge with a hobby knife or scissors as shown in Figure 4.

If after cutting it out you notice any cardstock that overhangs the sides of the ring, you can sand the overlap off

Figure 5: Sand off any overlap that prevents the disk from fitting into the payload bay tube.

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with a sanding block and a piece of sand paper. You want the ring and disk to slide easily into the tube.

Step 3. Glue the ring and disk assembly into the payload tube.

I suggest that you put the ballast compartment towards the forward part of the rocket. There are several reasons for this, and I'll list them for you so you understand the process you need to go through as you start designing your own rockets.

First of all, the manufacturers of the altimeters suggest that you put the vent hole a certain distance back from the base of the nose cone. The further back, the better. There is going to be turbulent airflow coming off the joint where the nose meets the front of the payload tube. Your vent hole for the altimeter needs to stay out of this region, or it could give you false altitude readings. Therefore by putting the ballast compartment on top of the altimeter section, you are moving the vent hole back down away from the nose. This is good.

Second, as you're putting the sand or the powder into the tube, it is probably going to leave a little residue on the inside edges of the tube. This is going to change the fit of the shoulder as it goes into the tube.

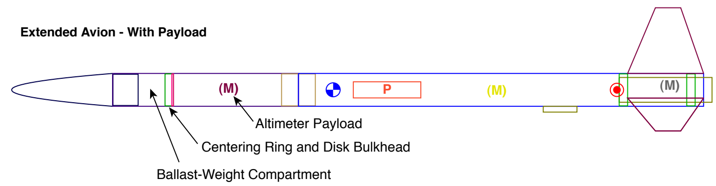

Figure 5: General layout of a good science fair rocket.

Do you understand what I'm talking about? Think of it this way. Here is an experience all rocketeers know about. After you've launched a rocket a few times, there is ejection charge residue that builds up on the inside of the forward end of the tube. You can feel its grittyness as you slide the nose cone on the rocket. The same gritty feeling will occur when you put the nose cone on the payload tube after you put in the ballast sand.

The gritty feeling is more than a nuisance, it actually changes the grip of the nose cone fit. In other words, the nose cone may pull off easier. On a payload rocket, we don't want the nose cone to come off, do we?

Imagine what could happen if the ballast compartment was on the bottom of the payload bay? Instead of changing the fit of the nose cone, the dirt will change the grip of the coupler on the base of the payload tube. Picture that, so you understand what I'm talking about.

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Therefore, the coupler could come out by accident. And when would that accident occur? Right… at the ejection of the rocket. This means the payload bay (that houses the expensive altimeter) and the nose cone would separate completely from the rest of the rocket. It would mean the entire payload section tumbling down and very likely getting lost.

I would rather the nose cone pop off and get lost than

Figure 6: To adjust the fit of the coupler, wrap tape around the forward end to achieve a tight fit.

Figure 7: The coupler inserted into the bottom end of the payload bay tube.

the coupler coming out and the whole payload bay getting lost. Nose cones are much cheaper than altimeters.

Those are the two big reasons why I think you should put the ballast compartment toward the front end of the payload tube.

Step 4. The coupler that is inserted into the back end of the payload tube cannot be glued on. Why? So that the altimeter can be taken out and turned on and off between

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flights.

The fit of the coupler is “critical” to mission success. It has to be a tight fit. Remember, we just finished talking about this. If it comes out at ejection, you’re going to lose the altimeter and the nose cone.

To adjust the fit of the coupler, add tape around the front end so that it is a tight fit into the payload bay tube.

That is basically it. You’ll finish the preparation of the rocket by attaching the parachute and the shock cord to the screw eye (or parachute loop) on the base of the coupler.

Conclusion

Now that you have this great research rocket, I’m sure that you’ll be able to get excellent results from your experiments. All your rockets will weight the same, which is a critical step in the scientific process.

If you want more visuals on how to create this payload rocket, see our web site for a new how-to video. It is at: www.apogeerockets.com/Nose_Cone_science.asp.

About The Author:

Tim Van Milligan (a.k.a. “Mr. Rocket”) is a real rocket scientist who likes helping out other rocketeers. Before he started writing articles and books about rocketry, he worked on the Delta II rocket that launched satellites into orbit. He has a B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University in Daytona Beach, Florida, and has worked toward a M.S. in Space Technology from the Florida Institute of Technology in Melbourne, Florida. Currently, he is the owner of Apogee Components (http://www.apogeerockets.com) and the curator of the rocketry education web site: http://www.apogeerockets.com/education/. He is also the author of the books: *“Model Rocket Design and Construction,” “69 Simple Science Fair Projects with Model Rockets: Aeronautics”* and publisher of a FREE e-zine newsletter about model rockets. You can subscribe to the e-zine at the Apogee Components web site or by sending an e-mail to: ezine@apogeerockets.com with “SUBSCRIBE” as the subject line of the message.

Reader Questions About Cluster Motor Models

By Tim Van Milligan

Dan Hoffman asks, *"I launched a LandViper cluster rocket, B6-4 x3, at a recent launch and at ejection, the shock cord zipped the body tube and the nose and parachute separated from the main rocket body. My question is, would a baffle help prevent this from happening with a cluster rocket?*

Response

I like this question, because it shows the importance of flying skills, which are often overlooked by modelers. An ejection baffle (www.apogeerockets.com/Ejection_baffles.asp) would not help in this instance. A zipper is usually a result of the rocket deploying the recovery device when it is traveling too fast, either going up too fast, or arcing over and coming down too fast. My guess is that since it was a cluster, which has the potential to fly really high, it was still heading up when the recovery device was deployed. The solution would be to use a longer ejection delay in the motors so the deployment velocity is lower.

If you are using the RockSim software, check to see that the "velocity at deployment" is lower than 35 miles per hour. That is my own personal rule-of-thumb for the maximum speed when the chute comes out to avoid damage to the rocket or recovery device.

You should also double or triple the length of the shock cord (www.apogeerockets.com/shock_cord.asp). That will allow the rocket a chance to slow down before being yanked back by the chute.

While I don't know if I'd recommend it, another solution would be to add weight to the rocket so it doesn't go as fast. You might also add some drag to the rocket, but that would be a last resort option.

Cluster Rocket Question #2

David Hurlburt writes: "*I just opened my new kit, Semroc DEFENDER and I am really looking forward to a great build and a terrific rocket. But I have a question about the engine retention.*

"My concern is that I will not have enough room to adequately tape the engines to the engine tubes.

"I do not want to put tape around the engine for a friction fit, so I am considering using flexible wire as you demonstrate in chapter 6, pp 99 Model Rocket Design and Construction *(third edition).*

"I know that you always build and fly the kits that you

Semroc Defender

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Questions About Cluster Engine Rockets

sell, so I was wondering what method you used for engine retention in this case?"

The Semroc Defender (www.apogeerockets.com/Semroc_Defender.asp) is a great kit, and if you're the type of person that likes unique looking rockets, I'm sure you'll like this kit a whole lot.

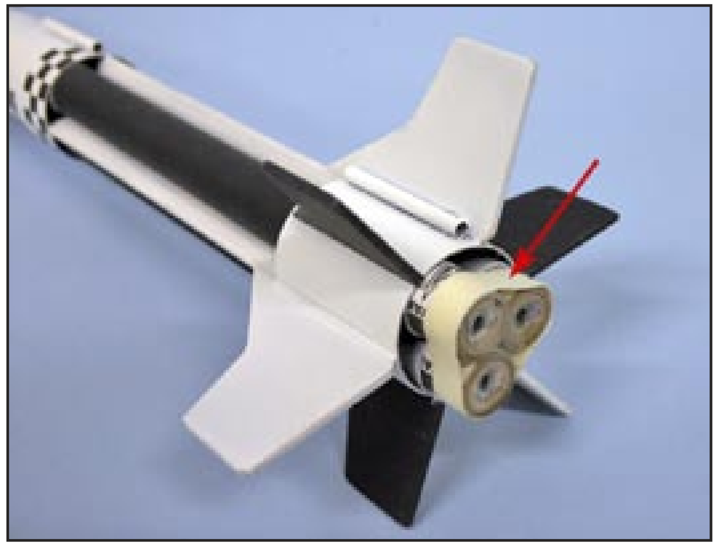
The instructions for the kit say to friction fit them into place. As you may know, I'm not a fan of friction-fitting motors into the rocket. For me, it is a method of last resort.

The flexible wire method, which you mentioned, will work fine on this rocket. But you really need to plan that in advance prior to building the rocket. Otherwise, it would be a real chore to add it after-the-fact.

Here is a simpler trick for you that works well with three-engine cluster rockets like the Denfender. Start by doing a light friction fit of the motors into the tube. Use just enough tape to prevent the motors from falling out of the tube, but not enough that it would be even a snug fit.

Then simply wrape tape around the exposed ends of the rocket engines as shown in the photo.

It doesn't appear that anything is holding the motors in, but this really does work. "Why?" you ask.



Tape wrapped around the ends of the motors is enough to prevent them from being spit out at ejection.

It is kinda like one of those chinese finger handcuff toys. If one motor tries to pop out, it tries to bend the other two over to its side. It actually wedges those two in tighter in their respective tubes. So then none of them can come out.

As you can see in the photo of the rocket I flew, all the motors are still in place after the flight. Cool, Huh?