PEAK OF FLIGHT NEWSLETTER

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APOGEE COMPONENTS

PEAK OF FLIGHT

What Size Parachute Should I Use ?

By Tim Van Milligan

This is a common question we're asked here at Apogee Components. The answer depends on a lot of variables, which makes it difficult for us to give customers a specific answer when they ask what size parachute should I use.

Figure 1: Basic hexagon parachute

We've written about this subject a number of times in this newsletter, going over the specific variables that have to be taken into account (see the references at the end of this article). But most modelers don't know the conditions they are going to fly their rockets in, and are just looking for a simple answer.

Because of that, in this article I'm going to plug in some simple assumptions on the conditions for the rocket, and then give you some look-up charts that will give you a rough guesstimate on the size of the parachute you'll need for your rocket.

The charts shown here are based on these simplifying assumptions:

Assumption 1 - The Drag Coefficient of the Parachute is 0.75

The drag coefficient is a dimensionless number that tell us how efficient a parachute is at creating drag, which is the force that is trying to counteract gravity as the rocket is coming down.

Some parachute shapes are more efficient than others, and hence they create more drag for the surface area of canopy. But here we're assuming that these are average flat sheet parachutes with lines attached at the corners of the sheet.

If you believe your parachute is more efficient, than you can use higher weights for your descent mass as shown in the charts on pages 4-5.

Assumption 2 - Standard Atmosphere Day

When NASA makes up the charts that give the density of the air, they have to assume some consistent weather conditions. For example, the temperature of the air is around 59°F. That is cool for a hot summer day, but warm if you're flying your rockets in the winter time in Michigan.

Weather conditions, like temperature, affect the flight by changing the air density. On cold days the air is denser, and it makes your rocket fall slower. On a hot day, the air density is reduced and the rocket will fall faster towards the ground.

Assumption 3 - Launching at Sea Level

The big variable for parachute performance, as you can tell by this assumption and the previous one, is about the density of the air. The launch elevation affects the density as well. At sea level, air is pretty thick. At higher elevations, like here in Colorado, the air is thinner and the parachute will fall faster.

I did a quick calculation of the density of the air where I was launching rockets yesterday in Hartsel, Colorado. It is a launch site that is at 8,774 feet in elevation. With the actual weather conditions taken into account (53°F temperature, Relative Humidity of 21%, and a barometric pressure of 30.1 inches of Mercury), the density of the air was less than half that of sea level. That makes a big difference, and the rockets fall a lot faster to the ground.

You can tell the air is thin when you're in the mountains of Colorado. Especially when you start running after your rocket and you feel out of breath a lot sooner that you would if you were in Kansas.

Assumption 4 - You have an average strength rocket

How strong is your rocket? This is a question nobody knows the answer to, because the only way to find out how strong it is, is to drop it hard onto the ground until you break something off.

Nobody wants to break their rocket, so they don't do this test. Never have I had a person answer this question.

But it is probably the most important question you should answer. Basically, it is how high can you drop your rocket and not have anything snap off.

The charts on pages 4-5 show the average descent speeds: slow versus fast. You'll have to pick one.

For slow descent, we'll assume that your rocket can survive a fall to the hard ground without breaking from a height of two feet. We'll define a fast descent as being able to survive a fall from three feet above the ground.

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For example, imagine your rocket is sitting on your desk, and you knock it hard, and it flies off the surface and lands on the floor. If it survived without breaking off a fin, then it can withstand a “fast descent” (a speed of about 4.5 m/s). If you don’t think it could survive the fall from the table, then you should say that your rocket has to land with a slow descent speed.

How to use the charts

- **Step 1 -** Find the chart that corresponds to the shape of your parachute. If you are using a hexagon shaped parachute, find the table that lists hexagon parachute.

- **Step 2 -** Weigh your rocket. Use a gram scale. Ideally you want the descent weight, which is with the rocket motor installed, but all the propellant is consumed. Use a spent (empty) motor casing if you have it. If you don’t have an empty motor case, don’t worry about it. Use whatever weight you have. These charts are for making a first guess. It will probably work close enough for you to get your rocket back without too much damage.

- **Step 3 -** Decide if your rocket is weak or strong. If it is a weak rocket (has big fins that are just surface mounted to the tube), then you should be selecting a slow descent speed. If it can survive a higher fall without breaking, then you can select a size where the descent speed is higher.

- **Step 4 -** Once you’ve decided on a slow or a fast descent speed, you can go down the column and look for a weight that is close to what your rocket is. Obviously, it won’t be exact. You’ll probably have a choice between two sizes of parachutes. That is to be expected.

- **Step 5 -** If you have to pick between two chute sizes, opt your decision toward the larger parachute.

We would use the larger size, even though it will make the rocket descend slower. We can always reef the parachute or cut a spill hole into it later if we think it is coming down too slow. You can always use techniques like that to make a chute fall faster, but you’ll never be able to make it fall slower. So start with a chute that is slightly bigger than you think you need.

Example on Choosing a Parachute

For example, say you have a rocket that weighs 118 grams with a spent motor installed. You look at what you have in your range box, and all the chutes are a hexagon shape. You assume your rocket is fairly fragile because it has really big fins that don’t have big fin fillets on them.

You would then go to the hexagon chart and look at the “slow speed” column.

Unfortunately, you don’t see a number that is exactly 118 grams in the “slow descent” column. You do see a 104 grams for the 18-inch parachute, and then below it, you see 184 grams for the 24-inch parachute. Which do you use?

I would suggest the 18-inch parachute. Here is my reason: The 15-inch parachute can handle a 118 gram model, but the descent rate is close to the high speed. On the 18-inch, a mass of exactly 104 would give you a slow descent speed. So 118 grams would probably come down slightly faster, but not even close to the fast descent speed.

What would happen if you went to the next size up, which is the 24-inch parachute? Basically, it would be coming down at a slower speed and really drift a long way with the wind. The whole purpose of these charts is to get a safe landing speed without having to walk so far to retrieve it.

Test Fly

For most modelers, as long as the rocket wasn’t lost (drifted away) and it doesn’t have damage, we’d consider that a successful flight. That means you’ve picked a good size parachute.

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From this point, you can decide to tweak the size of the parachute for the rocket if you want. Most people don't though. And that is OK. If you got your rocket back in one piece, all is good.

But if you decide you want to optimize the parachute size for the model rocket you're flying, we have other articles on our web site that will guide you through the process of refining your choice. See the references at the end of this article.

Circular Parachute Selection Chart

Diameter (inches)	Diameter (m)	Area (m^2)	Mass (Slow Descent)	Max. Mass - grams (Fast Descent)
8	0.20	0.0324	19	31
12	0.30	0.0730	41	69
15	0.38	0.1140	65	108
18	0.46	0.1642	94	156
24	0.61	0.2919	167	277
30	0.76	0.4560	262	432
36	0.91	0.6567	377	623
42	1.07	0.8938	512	848
48	1.22	1.1675	670	1107
58	1.47	1.7046	978	1616
72	1.83	2.6268	1506	2491

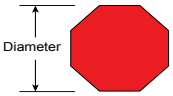
Figure 2: Circular parachute chart

Hexagon Parachute Selection Chart

Diameter (inches)	Diameter (m)	Area (m^2)	Mass (Slow Descent)	Max. Mass - grams (Fast Descent)
8	0.20	0.0358	21	34
12	0.30	0.0805	46	76
15	0.38	0.1257	72	119
18	0.46	0.1810	104	172
24	0.61	0.3218	184	305
30	0.76	0.5029	288	477
36	0.91	0.7241	415	687
42	1.07	0.9856	565	935
48	1.22	1.2873	738	1221
58	1.47	1.8796	1078	1782
72	1.83	2.8964	1662	2747

Figure 3: Hexagon parachute chart

Octagon Parachute Selection Chart



Diameter (inches)	Diameter (m)	Area (m^2)	Mass (Slow Descent)	Max. Mass - grams (Fast Descent)
8	0.20	0.0358	20	32
12	0.30	0.0805	44	73
15	0.38	0.1257	69	114
18	0.46	0.1810	99	164
24	0.61	0.3218	177	291
30	0.76	0.5029	275	456
36	0.91	0.7241	397	657
42	1.07	0.9856	541	894
48	1.22	1.2873	706	1168
58	1.47	1.8796	1031	1705
72	1.83	2.8964	1589	2627

Figure 4: Octagon parachute chart

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The Vortex Ring Decelerator

In Peak-of-Flight Newsletter #492: *Build Your Own Helicopter Parachute - Part 1*, Dave Flanagan created plans for a new type of parachute called the Vortex Ring Decelerator. It is designed to rotate like a helicopter as it falls. The theory is that it produces more drag than a chute that doesn't rotate.

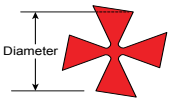
I really liked the design and the simplicity of the pattern. So I asked Pat Butler at Dino Chutes to make me one out of nylon cloth to test out.

Figure 5: Vortex Ring Decelerator parachute

I've flown it four times, and every time it has worked and people have marveled at how cool it looks at it comes down. Based on that, I knew it would be a cool product, so I've ordered a whole bunch from Dino Chutes and we'll be selling them in the ApogeeRockets.com web store.

I also flew a Jolly Logic AltimeterThree (https://www.apogeerockets.com/Electronics-Payloads/Altimeters/Jolly-Logic-AltimeterThree) in the rocket with the parachutes to find the descent rate of the Vortex Ring Decelerator. I followed the procedure of determining the Cd of the parachute that was written about in Peak-of-Flight Newsletter #449: *How to Determine the C_d of a Parachute*. I was surprised to see that the C_d was pretty high. It came in at 1.63. This confirms what Dave Flanagan said, which is that it is about double that of a regular model rocket parachute.

Vortex Ring Decelerator Parachute Selection Chart



Diameter (inches)	Diameter (m)	Area (m^2)	Mass - grams (Slow Descent)	Max. Mass - grams (Fast Descent)
8	0.20	0.020	25	41
12	0.30	0.042	52	86.6
15	0.38	0.066	82	136
18	0.46	0.095	118	196
24	0.61	0168	209	346
30	0.76	0.286	357	589
36	0.91	0.411	512	848
42	1.07	0.486	606	1002
48	1.22	0.634	790	1307
58	1.47	0.926	1154	1908
72	1.83	1.427	1779	2941

Figure 6: Vortex Ring Decelerator parachute chart

What this means is that the Vortex Ring Decelerator style parachute can carry a heavier load for the same descent speed! And the canopy has less surface area, so it can be put into a smaller space inside the rocket.

While Vortex Ring Decelerator chutes are more efficient, I did find them to be tricky to prep for flight because they don't fold as easily. Because of this, I don't think regular parachutes will go away anytime soon. "Convenience" plays a big role in selecting a parachute too.

References:

Properly Sizing Your Rocket's Parachute - https://www.apogeerockets.com/education/downloads/Newsletter149.pdf

Everything You Wanted To Know About Parachutes - By Dave Virga https://www.apogeerockets.com/education/downloads/Newsletter184.pdf

Sport Parachuting Technology Applied to Rocketry - Annette Sostarich https://www.apogeerockets.com/education/downloads/Newsletter279.pdf

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Simulating Cluster Parachutes in RockSim - https://www.apogeerockets.com/education/downloads/Newsletter354.pdf

Selecting the Proper Size Drogue Parachute - https://www.apogeerockets.com/education/downloads/Newsletter361.pdf

How to Determine the Cd of a Parachute - https://www.apogeerockets.com/education/downloads/Newsletter449.pdf

Build the Vortex Ring Decelerator Parachute - https://www.apogeerockets.com/education/downloads/Newsletter492.pdf

Air Density Calculator - https://www.engineersedge.com/calculators/air-density.htm

About The Author:

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who likes helping out other rocketeers. He is an avid rocketry competitor and is Level 3 high power certified. He is often asked what is the biggest rocket he's ever launched. His answer is that 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 an M.S. in Space Technology from the Florida Institute of Technology in Melbourne, Florida. Currently, he is the owner of Apogee Components (www.apogeerockets.com) and also the author of the books: Model Rocket Design and Construction, 69 Simple Science Fair Projects with Model Rockets: Aeronautics and publisher of the "Peak-of-Flight" newsletter, a FREE ezine newsletter about model rockets. You can email him by using the contact form at https://www.apogeerockets.com/Contact.