John Becker graduated from Wheaton North High School where he was an active member of the marching band and pep band. A chemistry major with interests in chemistry and rocketry, he still keeps up with his musical pursuits as a member of NIU’s marching band. John hopes to be a chemistry professor one day. This essay is important to John because it is a personal account of what he describes as one of the happiest days of his life, and it also highlights his interest in rockets.

John wrote this essay in John Bradley’s English 105 course.
I mass the second white powder, but I do it in a way that most people could not. I know that increasingly accurate massing will result in increasingly superior rocket fuel. My balance is precise, down to a twentieth of a gram, but I wish it was more precise. My calculations for the perfect ratio are to the thousandth of a gram. I settle for what I have and end up with 648.07 grams of my oxidizer. I pour it into the huge Ziploc bag that sits next to the scale on the kitchen counter, adding the oxidizer to the 351.93 grams of powdered sugar that serves as the fuel. I smile, and while I mix the two powders, I sing to the old Batman theme: “Shakey, shakey, shakey, shakey, shakey, shakey, shakey, shakey, shakey, shakey. Rocket Fuel! Rocket Fuel!”

It took me years to find a way to get the potassium nitrate that I used to oxidize the powdered sugar. I eventually found a place online where I could get it for a little more than two dollars per pound, including shipping. Once I actually had the stuff, I had to figure out how to use it. I knew more about chemistry than the average high school freshman, but not all that much more. So I read. And read, and read, going through most of the books in my school’s library that dealt with chemistry and all the ones that even mentioned rockets. Using a triple beam balance given to me by my aunt, I made countless small batches of rocket fuel, only to immediately rush outside to burn them. By looking at what was left over, I could tell whether I had too much fuel or too much oxidizer. From that, I guessed at an ideal ratio. Only later, in my advanced chemistry class, did I learn how to do the calculations based on the chemical formulas of the reactants and products. My first ratio was a little off.

I leave the thoroughly mixed powders to solidify. The fuel is more compact and burns more completely that way, and I am not quite ready to make more rockets yet. After a few days of school, which I spent formulating thought experiments in my head, I have come up with a new design that will allow me to stuff even more fuel into the rocket. I designate this new design the Silver cap.

Once I had figured out a rough ratio by trial and error, I started to design the rocket engine proper. I had used premade model rocket engines
before, and they were made of a thick body of tightly wound paper and an epoxy nozzle. Knowing that I had to make an engine before I could put a nozzle on it, I started work on the engine body. After several miserable failures, I concluded two things: the paper engine bodies took a long time to make, and I could not make them consistently from one to the next. I searched the house for things that, in addition to being able to withstand the heat and pressure found inside a rocket engine, were also consistent from one to the next, but above all, dirt cheap to acquire. After two hours, I gave up for the day and headed up from the basement to play games on the computer. As I passed through the kitchen, I saw something out of the corner of my eye. My brother’s used medicine vials were sitting out in preparation for recycling. I picked one up and looked at it closely. It had a body larger than the nozzle, but the nozzle was still large enough for me to fill it with rocket fuel easily. And, it was made of glass, so it could take the heat. But, most of all, there were dozens of them, and they were free for the taking. I had found my rocket body.

I dunk the entire vial into the mixed powders, forcing them into it using my index finger until I can fit no more inside it. If I were to use it now, I would call it a *Yellow cap*—simply filled with powder and lit from the open nozzle. Using a drill bit, I hollow out the middle of it, promoting it to *Blue cap*—filled with powder and hollowed out so that it has a much larger burning surface, and subsequently, more thrust. I am still not done, as I have far grander things in mind. While the venerable *Blue cap* has more thrust than it does weight, its thrust is vaguely directed out of a very wide nozzle. Fixing this is the basis of my new design. I place a small piece of molding clay into the nozzle, completely sealing it. Then I use the drill bit to make a small, rifled hole, which will now act as the nozzle.

Once I had my rocket engine, I tried to make rocket bodies for it to inhabit. Again, I drew on what I knew—the long body with fins on the end found on most model rockets. It was rough going. I made more than I care to think about, each one based on correcting the failings of its predecessors. One was too heavy for the engine to lift. The next was so light and flimsy that it broke apart on takeoff. Another was light, yet strong, but was highly asymmetrical, and it was crushed when it hit the ground before the engine even finished burning. Regardless of their individual shortcomings, they were always inconsistent and very time consuming to build. In desperation, I looked up rocket stabilization in my high school’s library. I didn’t have the supplies to actively stabilize it with gyroscopes or anything like that, and my aerodynamically stable designs were anything but. Then I saw it: a way to stabilize the rocket without having to make it
perfectly symmetrical, putting a gyroscope on it, or even making anything other than the engine, for that matter. I just had to make it spin.

Satisfied with the nozzle, I put the vial’s original metal cap back in its proper place, ensuring that the clay nozzle would stay put. I then add the final touch, a small trail of powder going through the nozzle to allow me to ignite the main charge without opening it up first. Placing the flagship of the new class on the counter, I start building a second Silver cap.

I now have a dilemma. Should I launch the twins from my back yard, and almost certainly lose one or both of them to collisions with the surrounding trees, or risk jarring the painstakingly positioned powders out of place by carrying them to a large clearing near my house that should offer the rockets entirely unobstructed flight paths. I decide to risk it.

With an open-ended metal tube under one arm, my blowtorch under the other, and a box of matches in my pocket, I gingerly carry the two beauties down two blocks to the clearing. I set up the metal tube against a small tree so that, once it clears the tube, the rockets will have an unobstructed flight for as far as they can go. I gently place one of the rockets on the ground behind a rock, well away from the tube, to ensure that if the first rocket explodes, it will not waste its twin by igniting it while it points into the ground. Taking the other rocket, I delicately place it into the launch tube. Stepping back, I extract my box of matches, light my blowtorch, adjust the flame, and light the powder trail.

I ready the second rocket, just as I had the first. With lighted blowtorch, I ignite the powder trail. It promptly dies. I remove the rocket from the tube, and sprinkle some more powder into the nozzle, replace it, and try again. It ignites, stuttering worryingly before lighting the main charge and pushing the rocket out of the tube on its own power. But I immediately sense that something is wrong. Sure enough, a foot after leaving the tube, it veers violently to the left and then begins something I have seen many times, spinning furiously on all three axes, doing what I call the death spiral. It is caused when there is uneven thrust that is not generalized and countered by the rocket spinning on its central, or z-axis. There is no hope for it to recover on its own, and I cannot help it as, despite it moving erratically, it is still moving far too fast for me to catch it. Although even if I could catch it, I would not, as by this point it might explode at any moment. So I watch as it spends all its fuel in around a second and, still spinning at a stupendous rate, falls to the ground. I walk over to it, and use a leaf to pick it up, as it is still very hot. There are no cracks in the vial itself, but the nozzle, probably weakened by the brief ignition of the first powder trail and cracked by the second, has partially blown out. With half
of the nozzle gone, and the thrust now directed at around thirty degrees to
the side, it could have done nothing but spin out... unlike its sister.

Once lit, her powder trail burned fast and true, promptly lighting the tip
of the main charge. Within milliseconds, the entire surface of the hollowed
out charge started to burn, and the pressure inside soared—causing the
powder to burn even faster—until the force of the thrust equaled, then
exceeded the force of gravity acting on the rocket, at which point it started
to move. It shot out of the launch tube, accelerating exponentially as the
thrust increased with the enlarging surface area, and the weight decreased
as gram after gram of powder deserted its position inside the rocket to join
the thick white cloud from the exhaust gasses. At first, it wavered slightly,
and I expected the worst; but as the rocket spun, the drift was countered,
making a brief corkscrew pattern. It probably continued to do this, but was
then moving and spinning so quickly that I just saw a growing white line
as my beautiful Silver cap soared into the endlessly blue sky. Brennschluss.
The end of burning. While the thrust may have been gone, the rocket still
had lots of kinetic energy. Marked by smoke from the last bits of slowly
burning powder hidden in the corners of the vial, the rocket continued
upwards. It peaked at around four hundred feet and landed around two
hundred feet away from me. I did not collect it, for there was nothing else
it could tell me—it had flown straight, which told me everything about it
that I would ever want to know.

I lean the well-singed veteran of countless launches, my formerly pure
white launch tube, back into its place against the garage wall, next to
my blowtorch. I walk into the house. When I see my mom, I tell her it
worked—the new design worked. She congratulates me, but it’s clear she
does not understand what she is congratulating me for. How could she
understand? It’s not her dream. She didn’t ever get into rocketry, or fall
in love with chemistry. But I did. And I had done it, that which I once
considered impossible; I had made a rocket. A working rocket, with a
working motor, that was capable of self-stabilized flight. Moreover, I had
done it cheap. I originally decided to make rockets so I wouldn’t have to
spend ten dollars on each engine for my model rocket and could instead,
make the engines myself for less than the pre-made ones cost. My goal was
to make rockets for nine dollars and ninety-nine cents or less. I missed
that goal by miles. The Silver cap, and its eventual successor, the mighty
Red-Silver, cost less than one cent each.