Rocketry Science Fair Project

Project Guidebook

By Aurora Lipper

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How to Use This Book:

Welcome to the world of Supercharged Science! In just a moment, you'll be blasting rockets, taking data, and transforming your great ideas into an outstanding science fair project! Whether you're looking to blow away the competition or happy just get a decent grade, you've got the keys to a successful science fair project in your hands right now. The tools you'll find in this manual answer the basic question: **"How can I create a science fair project and enjoy the process?"**

We're going to walk step-by-step through every aspect of creating a science fair project from start to finish, and we'll have fun doing it. All you need to do is follow these instructions, watch the video, and do the steps we've outlined here. We've taken care of the tricky parts and handed you a recipe for success.

Who am I? My name is Aurora, and I am a mechanical engineer, university instructor, airplane pilot, astronomer, and I worked for NASA during high school and college. I have a BS and MS in mechanical engineering, and for the past decade have toured the country getting kids wildly excited about doing *real* science.

What do the kids I teach learn? After a day or two, my students are building working radios from toilet paper tubes, laser light show from tupperware, and real robots from junk. And they're crazy-wild excited about doing it.

One of the problems kids have, however, is taking their idea and fitting it into something acceptable by science fairs or other technical competitions designed to get kids thinking like a real scientist.

Another problem kids often face is applying the scientific method to their science project. Although the scientific method is not the primary method of investigation by industry, it *is* widely used by formal science academia as well as scientific researchers. For most people, it's a real jump to figure out not only how to do a decent project, but also how to go about formulating a scientific question and investigate answers methodically like a real scientist. Presenting the results in a meaningful way via "exhibit board"… well, that's just more of a stretch that most kids aren't really ready for. And from my research, there isn't a whole lot of information available on how to do it by the people who really know how.

This report is designed to show you how to do a cool project, walk you through the steps of theorizing, hypothesizing, experimentation, and iterating toward a conclusion the way a real engineer or scientist does. And we'll also cover communicating your ideas to your audience using a display board *and* the oral presentation using top tips and tricks from real scientists.

For years, Supercharged Science has served as the bridge between the scientific community and the rest of the world. This is yet another step we have taken on to help serve as many families as possible. Thank you for your support and interest… and let's get started!

Materials List

Before we start, you'll need to gather items that may not be around your house right now. Take a minute to take inventory of what you already have and what you'll need.

Here's a shopping list of everything you need for this project:

Fuji film canister (get at least three)
Effervescent tablets (at least 48 tablets)
Water (distilled or tap)
Syringe to measure water or teaspoon/tablespoon measuring spoons
Measuring tape or meter stick (yard stick)
Thermometer to measure water temperature
Stopwatch or clock (optional)
Scale to measure weight of tablet (optional)
Camera to document project
Composition or spiral-bound notebook to take notes
Display board (the three-panel kind with wings), about 48" wide by 36" tall
Paper for the printer (and photo paper for printing out your photos from the camera)
Computer and printer

Create a Science Fair Project in Rocketry

Before we start diving into experimenting, researching, or even writing about the project, we first need to get a general overview of what the topic is all about. Here's a quick snippet about the science of rocketry.

Every flying thing, whether it's an airplane, spacecraft, soccer ball, or flying kid, experiences four aerodynamic primary forces: lift, weight, thrust and drag. A rocket uses combustion, chemical reactions, or air pressure to generate both thrust (forwards motion) and lift (upwards movement). The fins are used for stability, unlike an airplane where the wings actually generate lift. The smooth, pencil-thin *aerodynamic* rocket shape minimizes drag. And the molecules that make up the rocket attributes to the weight.

Think of a time when you were riding in a fast-moving car. Roll down the window and stick your hand out, palm down. Notice how easily the wind slips over your hand. Now turn your palm facing the horizon. Which way do you feel more force against your hand?

When designing airplanes, engineers pay attention to details, such as the size and shape of their flying machines. They also look at the position of two important points: the *center of gravity* and the *center of pressure* (also called the *center of lift*). On a rocket, if the location of the *center of gravity* and *center of pressure* points are swapped, the rocket's flight is unstable and somersaults chaotically (sick bags, anyone?).

Your first step: Doing Research. *Why* do you want to do this project? What originally got you interested in rockets? Is it the aerodynamic shape, the fin design, or do you just like blowing things up?

Take a walk to your local library, flip through magazines, and surf online for information you can find about rockets. Learn what other people have already figured out before you start re-inventing the wheel!

Flip open your science journal and write down things you've find out. Your journal is just for you, so don't be shy about jotting ideas or interesting tidbits down. Also keep track of which books you found interesting. You'll need these titles later in case you need to refer back for something, and also for your bibliography, which needs to have at least three sources that are not from the internet.

Your next step: Play with the experiment before you design the procedure. Place an effervescent tablet in a canister (you may need to break it into pieces) and fill part way with water. Working quickly, cap it and invert it on the sidewalk. Stand back… POP! You'll find there's an optimal water level for maximum height. If you work fast, you can get about four launches from one tablet. What happens if you try two tablets at once?

Why does that work? The tablets contain sodium bicarbonate (baking soda) and citric acid (a solid form of vinegar). What happens when you mix together vinegar and baking soda? It fizzes all over the place, doesn't it? Note that this reaction takes place because the vinegar (acetic acid) is in a liquid state. Notice how the effervescent tablets contain both chemicals, but they don't react until you get them wet.

(There's a more detailed description in the sample report, if you want to know more about what's *really* going, chemically-speaking.)

The chemical reaction of sodium bicarbonate and citric acid generates gas carbon dioxide gas bubbles (the same molecule you burp after chugging an entire soda), and those bubbles foam up and out of the canister. When you cap it, there's no room for the bubbles to go, and they build up pressure… and more pressure… and more pressure… until POP! There's so much pressure that the canister just can't hold it together anymore, and off flies the cap (or the canister, if you've inverted the canister).

Formulate your Question or Hypothesis: You'll need to nail down ONE question or statement you want to test if it is true. Be careful with this experiment - you can easily have several variables running around and messing up your data if you're not mindful. Here are a few possible questions:

- Do more tablets give a higher flight?
- Does more water give a higher flight?
- Does less water give a higher flight?

Once you've got your question, you'll need to identify the *control* and the *variable.* For the question: "Does more water give a higher flight?", your control would be one tablet, and your variable is the amount of water.

Taking Data: Sticking with the question "Does more water give a higher flight?", here's how to record data. Grab a sheet of paper, and across the top, write down your background information, such as your name, date, time of day, weather (and wind conditions), size of tablet (in weight, or grams - check the box), water temperature (in degrees), and anything else you'd need to know if you wanted to repeat this experiment *exactly* the same way on a different day.

Get your paper ready to take data… and write across your paper these column headers, including the things in ( ): (Note – there's a sample data sheet on page 10).

- Trial #
- Water (teaspoons)
- Time to Launch (seconds)
  Note: This is the time it takes for the rocket to pop after you've capped it.
- Maximum Altitude (feet)

Run your experiment starting with no water… while this seems pointless, you still need to test and see what happens. Plus, this is an excellent time to pull out your camera and get a good photo of you doing your experiment (you'll use this later on your display board). Run your experiment again and again, increasing the water amount by one teaspoon each time until you reach the volumetric limit of your film canister.

Hot Tip: Be sure to use a fresh tablet EACH TIME, or you'll also be varying the amount of tablet (chemical reactant) in this experiment as well. Don't forget to take photos as you go along - see if you can get a picture of the rocket actually blasting off the ground!

NOTE: Kodak (black) canisters will NOT work for this experiment!!

Analyze your data. Time to take a hard look at your numbers! Make yourself a grid (or use graph paper), and plot the *Altitude Height* (in feet) versus the *Water Amount* (in tsp). In this case, *Water Amount* goes on the horizontal axis, and *Altitude* goes on the vertical axis. You can make a second graph showing the *Altitude* (feet) and *Time to Launch* (seconds).

For Advanced Students: Use your projectile motion equations from physics to check your measurements against your theoretical values. You can even calculate percent error, too!

Conclusion: So - what did you find out? What water amount gives you the highest altitude? Is it what you originally guessed? Science is one of the only fields where people actually *throw a party* when stuff works out differently than they expected! Scientists are investigators, and they get *really* excited when they get to scratch their heads and learn something new.

One of the biggest mistakes you can ever make is to fudge your data so it matches what you wanted to have happen. Don't *ever* be tempted to do this… science is based on observational fact. Think of it this way: the laws of the universe are still working, and it's your chance to learn something new!

Recommendations: This is where you need to come up with a few ideas for further experimentation. If someone else was to take your results and data, and wanted to do more with it, what would they do? Here are a few spins on the original experiment:

Hot glue foam fins and a foam nose to the rocket body. Put the fins on at an angle and watch it spin as it flies upwards. You can also tip it sideways and add wheels for a rocket car. Stack them high for a multi-staging project, or strap three together with tape and launch them at the same time! You can also try different containers using corks instead of snap-on lids.

What other chemicals do you have which also produces a gas during the chemical reaction? Chalk, vinegar, baking soda, baking powder, hydrogen peroxide, isopropyl alcohol, lemon juice, orange juice…

Make the display board. Fire up the computer, stick paper in the printer, and print out the stuff you need for your science board. Here are the highlights:

- Catchy Title: This should encompass your basic question (or hypothesis).
- Purpose and Introduction: Why study this topic?
- Results and Analysis (You can use your actual data sheet if it's neat enough, otherwise print one out.)
- Methods & Materials: What did you use and how did you do it? (Print out photos of you and your experiment.)
- Conclusion: One sentence tells all. What did you find out?
- Recommendations: For further study.
- References: Who else has done work like this? (Wernher von Braun, Robert Goddard, etc.)

Outline your presentation. People are going to want to see you demonstrate your rockets, and you'll need to be prepared to answer any questions they have. We'll detail more of this in the later section of this guidebook, but the main idea is to talk about the different sections of your display board in a friendly, knowledgeable way that gets your point across quickly and easily. Test drive your presentation on friends and relatives beforehand and you'll be smoothly polished for the big day.

Sample Data Sheets

Rocket Data Log

Name Number/Size of Tablet

Date Water Temperature

Time Weather Conditions

Trial Number	Amount of Water	Time to Launch	Maximum Altitude
	(mL)	(seconds)	(feet)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Create this table yourself using Microsoft Excel. You can download your free copy at this link:

http://www.ability-usa.com/download.php

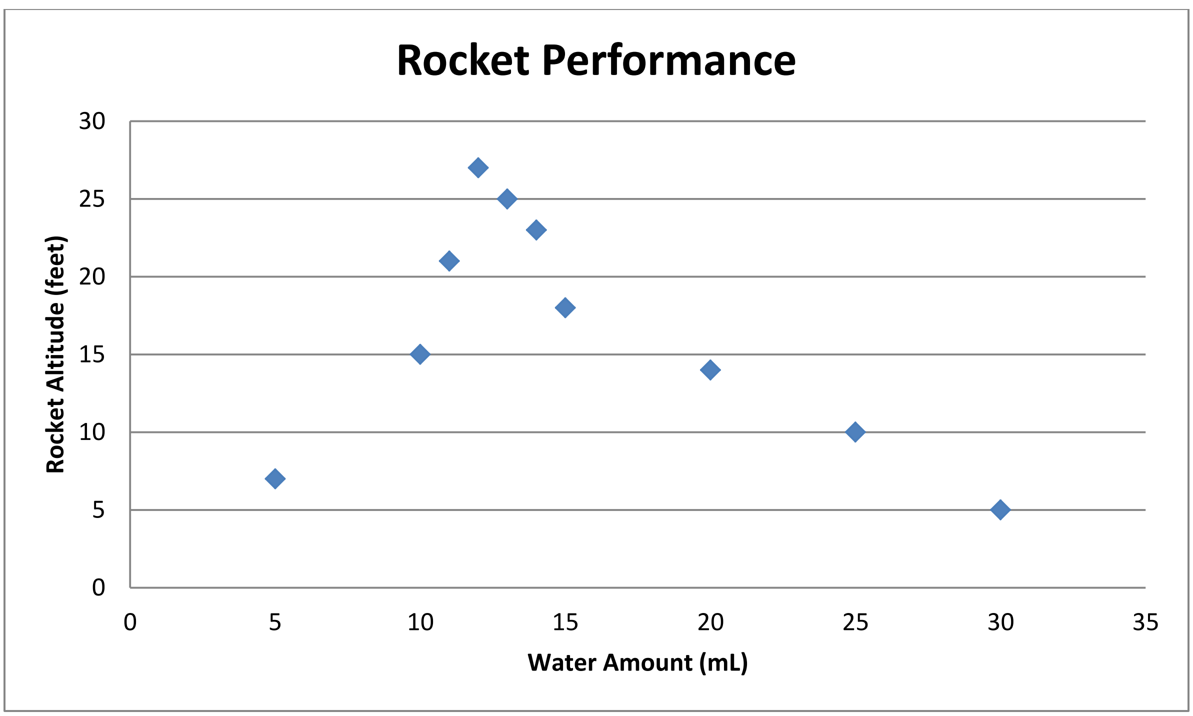
OR...download your free 60-day trail copy from Microsoft at this link:

http://office.microsoft.com/en-us/excel/default.aspx

SAMPLE Rocket Data Log

Name	*Aurora*	**Number/Size of Tablet**	*1 tablet*
Date	*November 12, 2009*	**Water Temperature**	*75 deg. F*
Time of Day	*12:05pm*	**Weather Conditions**	*Clear, 65 deg., calm*

Trial Number	Amount of Water	Time to Launch	Maximum Altitude
	(mL)	(seconds)	(feet)
1	5	5.4	7
2	10	3.2	15
3	15	4.6	18
4	20	2.3	14
5	25	2.1	10
6	30	1.9	5
7	11	4.4	21
8	12	4.5	27
9	13	4.3	25
10	14	4.2	23



Note – The numbers shown here are NOT from a real experiment… be sure to get your own!

Sample Report

In this next section, we've written a sample report for you to look over and use as a guide. Be sure to insert your own words, data, and ideas in addition to charts, photos, and models!

Title of Project

(Your title can be catchy and clever, but make sure it is as descriptively accurate as possible. Center and make your title the LARGEST font on the page.)

by Aurora Lipper

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Sacramento, CA 10101

Carmel Valley Grade School
6th grade

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Abstract

This is a *summary* of your entire project. Always write this section LAST, as you need to include a brief description of your background research, hypothesis, materials, experiment setup and procedure, results, and conclusions. Keep it short, concise, and less than 250 words.

Here's a sample from Aurora's report:

How high can a chemical reaction really power a rocket? After researching streamline designs by Bernoulli to minimize drag, multi-staging ideas from Robert Goddard to increase total rocket thrust, and taking a closer look at the chemical reaction of combining baking soda and vinegar, I realized I had all the basics for making a high-flying rocket. But how high could it really go?

I hypothesized the rocket would fly the highest when the most amount of chemical reactants were inside the rocket. Using generic effervescent tablets combined with water for the chemical reaction and a Fuji film canister for the rocket body, I ran ten trials varying the amount of water (increasing in increments of 5mL with each trial) combined with one standard effervescent tablet and measured the maximum altitude height reached using a measuring tape against a 30' high wall.

I found that my initial hypothesis was false. **The rocket actually flew the highest (27 feet vertically) when I combined one effervescent tablet with 12mL of water.** (It actually flew the poorest when I filled the entire canister with chemical reactants, as I originally had hypothesized.)

For further study, I recommend running an experiment to test the various available water types (tap water, distilled, filtered, etc.) and also another experiment to test for the ideal water temperature that will yield the highest rocket altitude. This experiment was a lot of fun, and had unexpected results, and I learned something new!

Introduction

This is where all your background research goes. When you initially wrote in your science journal, what did you find out? Write down a few paragraphs about interesting things you learned that eventually led up to your main hypothesis (or question).

Here is a sample from Aurora's report:

Rockets have been around for a long time. Black powder was first recorded being used in the 1st century, but it wasn't until the 9th century that the Chinese actually used gun powder to launch projectiles. Three hundred years later, the first rockets were being launched in China and the Orient, some as military applications, others as fireworks for royal celebrations.

Early rockets were hard to control, both from the lack of knowledge about aerodynamics as well as having the right tools for the job. Rockets would frequently veer sharply off-course and somersault unexpectedly, and it wasn't until the early 1900s when rocket designs were seriously improved by two great scientists: Robert Goddard and Wernher von Braun. Goddard figured out that rockets could be arranged in stages to reach higher altitudes, and von Braun's aeronautical designs made rocket flight stable and steerable.

Daniel Bernoulli in the 1700s figured out that the more streamline an object is, the more easily it slips through the air. This reminds me of when I stick my hand out the car window – if I face my palm toward the oncoming wind, I feel more form on my arm than when I have my palm down. My hand is more *aerodynamic* when it faces down, and has a lot more drag force when it faces the wind.

When researching rocket engines, I realized I needed a way to launch the rocket without using a combustion reaction. Chemical reactions involving baking soda and vinegar give off a lot of gas bubbles, and I wondered if using one of these to pressurize a small canister (rocket) could work. And what kind of gas does it give off?

The reaction of baking soda and vinegar is deceptively simple: what appears to be one reaction is actually two, happening in quick succession. The first reaction takes the vinegar and baking soda (sodium bicarbonate) and forms carbonic acid. But carbonic acid is really unstable (meaning that it falls apart easily), and it breaks into water and carbon dioxide as soon as it forms. This means that the gas bubbles are carbon dioxide, since carbon dioxide needs to be at -109^{o}F to become a solid. (Carbon dioxide goes straight from a solid to a gas (called sublimation) at temperatures above -109^{o}F.) The gas bubbles escape from the liquid (called effervescence), leaving water behind with a bit of sodium acetate in the water.

Purpose

Why are you doing this science fair project at all? What got you interested in this topic? How can you use what you learn here in the future? Why is this important to you?

Come up with your own story and ideas about why you're interested in this topic. Write a few sentences to a few paragraphs in this section.

Hypothesis

This is where you write down your speculation about the project – what you think will happen when you run your experiment. Be sure to include *why* you came up with this educated guess. Be sure to write at least two full sentences.

Here's a sample from Aurora's report:

My hypothesis is that the more water used in the rocket, the higher it will fly. The combination of water and effervescent tablets generates carbon dioxide gas, which pressurizes the rocket (film canister). My best educated guess is that the more water I use, the more gas is produced, and the higher the rocket will fly.

Materials

What did you use to do your project? Make sure you list *everything* you used, even equipment you measured with (rulers, stopwatch, etc.) If you need specific amounts of materials, make sure you list those, too! Check with your school to see which unit system you should use. (Metric or SI = millimeters, meters, kilograms. English or US = inches, feet, pounds.)

Here's a sample from Aurora's report:

Fuji film canister (2.45 in^3 or 40.2 cm^3)
Effervescent tablets (3.4 grams each)
Water (75^{o}F distilled, used in 5mL increments)
Syringe to measure water (5mL)
Measuring tape
Digital thermometer
Stopwatch
Scale to measure weight of tablet
Camera to document project
My Science Journal to take notes

Procedures

This is the place to write a highly detailed description of what you did to perform your experiment. Write this as if you were telling someone else how to do your exact experiment and reproduce the same results you achieved. If you think you're overdoing the detail, you're probably just at the right level. Diagrams, photos, etc. are a great addition (NOT a substitution) to writing your description.

Here's a sample from Aurora's report:

First, I became familiar with the experiment and setup. I plopped an effervescent tablet into a glass of water and watched it fizz. Then I tried the same thing in a film canister and snapped the lid on and watched what happened. After about four or five runs, I began to figure out how to get the film top on before the rocket exploded. Getting familiar with your equipment is a vital first step!

Once I was comfortable with the setup, I could now focus on my variable (water level) and how to measure it. I found a very tall grown up, a ladder, and a telephone pole and had my helper make chalk marks in increments of one foot from the sidewalk to 30' above the ground. I made sure to perform this experiment in the morning when the winds were calm, and ran through all my trials at the same time of day to minimize my variables.

I made myself a data logger in my science journal, and then brought my materials for this experiment outside. Using my digital thermometer, I first measured my pint of distilled water and recorded the water temperature in my science journal. Filling my syringe with water, I squirted 5mL of water carefully into a white Fuji film canister. I unwrapped one effervescent tablet, plopped it in and quickly snapped on the lid and inverted it top-side-down onto the sidewalk about a foot away from the marked telephone pole and waited for the launch. My assistant was armed with a stopwatch timer and measured from the time the reaction began (when I plopped in the tablets) to the time the rocket had just launched. (We didn't end up using this measurement.)

When the rocket reached maximum height, I recorded the measurement taken by eye in my data sheet. (We also took video so we could rewind and see the rocket against the pole, but we needed to first paint the rocket bright orange in order for the tiny rocket to show up on film.)

After the first trial, I collected the canister and lid, cleaned and dried both, and used 10mL of water and a fresh effervescent tablet in the container. I continued this process, increasing the amount of water by 5mL with each trial, then went back to test specific amounts later.

Results

This is the data you logged in your Science Journal. Include a chart or graph – whichever suits your data the best, or both if that works for you. Use a scatter or bar graph, label the axes with units, and title the graph with something more descriptive than "Y vs. X or Y as a function of X". On the vertical (y-axis) goes your dependent variable (the one you recorded), and the horizontal (x-axis) holds the independent variable (the one you changed).

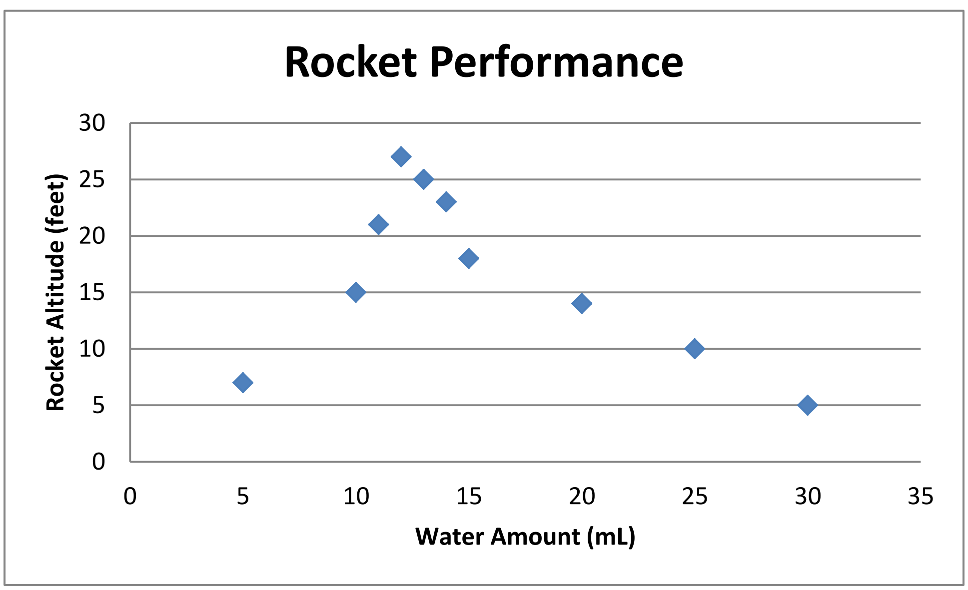
Here's a sample from Aurora's report on the next page.

The results from the experiment are shown in the table and chart below.

Rocket Data Log

Name	Aurora Lipper	**Number/Size of Tablet**	3.24 grams per tablet
Date	12/02/2009	**Water Temperature**	75 °F
Time of Day	9:54 am	**Weather Conditions**	Calm, sunny, 65°F

Trial Number	Amount of Water	Time to Launch	Maximum Altitude
	(mL)	(seconds)	(feet)
1	5	5.4	7
2	10	3.2	15
3	15	4.6	18
4	20	2.3	14
5	25	2.1	10
6	30	1.9	5
7	11	4.4	21
8	12	4.5	27
9	13	4.3	25
10	14	4.2	23



Conclusion

Conclusions are the place to state what you found. Compare your results with your initial hypothesis or question – do your results support or not support your hypothesis? Avoid using the words "right", "wrong", and "prove" here.   Instead, focus on what problems you ran into as well as why (or why not) your data supported (not supported) your initial hypothesis. Are there any places you may have made mistakes or not done a careful job? How could you improve this for next time? Don't be shy – let everyone know what you learned!

Here's a sample from Aurora's report:

I found that my data from this experiment did not support my hypothesis. The rocket actually flew the highest (27 feet vertically) when I combined one effervescent tablet with 12mL of water. (It actually flew the poorest when I filled the entire canister with chemical reactants, as I originally had hypothesized.)

I did not have absolute control over the outside weather conditions, which may have affected my rocket's performance a bit. Next time, I'd recommend doing this indoors in a large (and tall) building, such as a gymnasium. I also didn't have the best measuring device, as I had to estimate by eye the actual height of something tiny flying nearly 30' above my head. Next time, I can use a height gauge (a plumb bob attached to a protractor with a straw to peek through) and a bit of geometry to find the altitude more accurately.

For further study, I recommend running an experiment to test the various available water types (tap water, distilled, filtered, etc.) and also another experiment to test for the ideal water temperature that will yield the highest rocket altitude. This experiment was a lot of fun, and had unexpected results, and I learned something new!

Bibliography

Every source of information you collected and used for your project gets listed here. Most of the time, people like to see at least five sources of information listed, with a maximum of two being from the internet. If you're short on sources, don't forget to look through magazines, books, encyclopedias, journals, newsletters… and you can also list personal interviews.

Here's an example from Aurora's report:
(The first four are book references, and the last one is a journal reference.)

Fox, McDonald, Pritchard. Introduction to Fluid Mechanics, Wiley, 2005.

Hickam, Homer. Rocket Boys, Dell Publishing, 1998.

Gurstelle, William. Backyard Ballistics, Chicago Review Press, 2001.

Turner, Martin. Rocket and Spacecraft Propulsion. Springer Praxis Books, 2001.

Eisfeld, Rainer. "The Life of Wernher von Braun." Journal of Military History Vol 70 No. 4. October 2006: 1177-1178.

Acknowledgements

This is your big change to thank anyone and everyone who have helped you with your science fair project. Don't forget about parents, siblings, teachers, helpers, assistants, friends…

Formatting notes for your report: Keep it straight and simple: 12 point font in Times new Roman, margins set at 1" on each side, single or 1.5 spaced, label all pages with a number and total number of pages (see bottom of page for sample), and put standard information in the header or footer on every page in case the report gets mixed up in the shuffle (but if you bind your report, you won't need to worry about this). Create the table of contents at the end of the report, so you can insert the correct page numbers when you're finished.

Add a photo of your experiment in action to the title page for a dynamic front page!

Exhibit Display Board

Your display board holds the key to communicating your science project quickly and efficiently with others. You'll need to find a tri-fold cardboard or foam-core board with three panels or "wings" on both sides. The board, when outstretched, measures three feet high and four feet long.

Your display board contains *all* the different parts of your report (research, abstract, hypothesis, experiment, results, conclusion, etc.), so it's important to write the report *first*. Once you've completed your report, you'll take the best parts of each section and print it out in a format that's easy to read and understand. You'll need to present your information in a way that people can stroll by and not only get hooked into learning more, but can easily figure out what you're trying to explain. Organize the information the way museums do, or even magazines or newspapers.

How to Write for your Display Board Clarity and neatness are your top tips to keep in mind. The only reason for having a board is to communicate your work with the rest of the world. Here are the simple steps you need to know:

Using your computer, create text for your board from your different report sections. You'll need to write text for the title, a purpose statement, an abstract, your hypothesis, the procedure, data and results with charts, graphs, analysis, and your conclusions. And the best part is - it's all in your report! All you need to do is copy the words and paste into a fresh document so you can play with the formatting.

The title of your project stands out at the very top, and can even have its own 'shingle' propped up above the display board. The title should be in Times New Roman or Arial, at least 60 pt font... something strong, bold, and easy to read from across the room. The title has to accurately describe your experiment *and* grab people's attention. Here are some ideas to get you started:

- Burp-Blasting Rockets: Determining the Ideal Mixture in a Chemical Reaction
- How to Belch a Rocket: Studying the Principles of Pressurization and Propulsion
- Flameless Rockets: The Effect of Temperature on a Chemical Reaction
- How to Turn your Indigestion into Rocket Fuel: Investigating the Thrust Ratio of a Rocket

On the left panel at the top, place your abstract in 16-18 pt font. Underneath, post your purpose, followed by your hypothesis in 24 point font. Your list of materials or background research can go at the bottom section of the left panel. If you're cramped for space, put the purpose in the center of the board under the title.

In the central portion of the board, post your title in large lettering (24-60 pt. font). (You can alternatively make the title on a separate board and attach to the top of the display board… which is *great* if you really want to stand out!) Under the title, write a one-sentence description of what your project is really about in smaller font size (24-48 pt. font) Under the title, you'll need to include highlights from your background research (if you haven't put it on the left panel already) as well as your experimental setup and procedures. Use photos to help describe your process.

The right panel holds your results with prominent graphs and/or charts, and clear and concise conclusions. You can add tips for further study (recommendations) and acknowledgements beneath the conclusions in addition to your name, school, and even a photo of yourself doing your project.

Use white copy paper (*not* glossy, or you'll have a glare problem) and 18 point Times New Roman, Arial, or Verdana font. Although this seems obvious, spell-check and grammar-check each sentence, as sometimes the computer does make mistakes! Cardstock (instead of white copy paper) won't wrinkle in areas of high humidity.

Cut out each description neatly and frame with different colored paper (place a slightly larger piece of paper behind the white paper and glue in place. Trim border after the glue has dried. Use small amounts of white glue or hot glue in the corners of each sheet, or tape together with double-sided sticky tape. Before you glue the framed text descriptions to your board, arrange them in different patterns to find the best one that works for your work. Make sure to test out the position of the titles, photos, and text together before gluing into place!

In addition to words, be sure to post as many photos as is pleasing to the eye and also helps get your point across to an audience. The best photos are of *you* taking real data, doing real science. Keep the pictures clean, neat, and with a matte finish. Photos look great when bordered with different colored paper (stick a slightly larger piece of paper behind the photo for a framing effect). If you want to add a caption, print the caption on a sheet of white paper, cut it out, and place it near the top or bottom edge of the photo, so your audience clearly can tell which photo the caption belongs to. Don't add text directly to your photo (like in Photoshop), as photos are rich in color, and text requires a solid color background for proper reading.

Check over your board as you work and see if your display makes a clear statement of your hypothesis or question, the background (research) behind your experiment, the experimental method itself, and a clear and compelling statement of your results (conclusion). Select the text you write with care, making sure to add in charts, graphics, and photos where you need to in order to get your point across as efficiently as possible. Test drive your board on unsuspecting friends and relatives to see if they can tell you what your project is about by just reading over your display board.

How to Stand Out in a Crowd Ever try to decide on a new brand of cereal? Which box do you choose? All the boxes are competing for your attention… and out of about a hundred, you pick *one*. This is how your board is going to look to the rest of the audience – as just one of the crowd. So, how do you stand out and get noticed?

First, make sure you have a BIG title – something that can be clearly seen from across the room. Use color to add flair without being too gaudy. Pick two colors to be your "color scheme", adding a third for highlights. For example, a black/red/gold theme would look like: a black cardboard display board with text boxes framed with red, and a title bar with a black background with red lettering highlighted with gold (using two sets of "sticky" letters offset from each other). Or a blue/yellow scheme might look like: royal blue foam core display board with textboxes framed with strong yellow. Add color photographs and color charts for depth. Don't forget that the white in your textboxes is going to add to your color scheme, too, so you'll need to balance the color out with a few darker shades as you go along.

It's important to note that while stars, glitter, and sparkles may attract the eye, they may also detract from displaying that you are about 'real science'. Keep a professional look to your display as you play with colors and shades. If you add something to your board, make sure it's there to help the viewer get a better feel for your work.

For a rocketry exhibit, you can add tongues of flames up the edges of your display board and around the top of your board in red, orange, or gold. Add a 18" – 36" model rocket (if you have one nicely painted) poking out the top of your board as an attention-getter. Have a beaker filled with water and drop in a few tablets when people start passing by. Wear a lab coat and safety goggles, but be sure that the look you've got is professional, not costume.

If your fair allows for demonstrations, ask members of your audience to help run a set of experiments. You can demonstrate how to add the water and tablet to the canister, and quickly cap and invert the rocket into a metal pie pan. Or… string a long length of fishing line from the ceiling to your display table. Add a small straw to the rocket as a launch tube. Thread the string through the straw and pull both ends tight for a vertical "launch rail". Launch the rocket over a sheet of aluminum foil with a rim pinched up (so it can catch the drips) and you're sure to pull a crowd.

If you're stuck for ideas, here are a few that you might be able to use for your display board. Be sure to check with your local science fair regulations, to be sure these ideas are allowed on your board:

- Your name and photo of yourself taking data on the display board
- Captions that include the source for every picture or image
- Acknowledgements of people who helped you in the lower right panel
- Your scientific journal or engineer's notebook
- The experimental equipment used to take data and do real science
- Photo album of your progress (captions with each photo)

Oral Presentation

You're now the expert of the Rocket Science Experiment… you've researched the topic, thought up a question, formulated a hypothesis, done the experiment, worked through challenges, taken data, finalized your results into conclusions, written the report, and build a display board worthy of a museum exhibit. Now all you need is to prep for the questions people are going to ask. There are two main types of presentations: one for the casual observer, and one for the judges.

The Informal Talk In the first case, you'll need quick and easy answers for the people who stroll by and ask, "What's this about?" The answers to these questions are short and straight-forward – they don't want a highly detailed explanation, just something to appease their curiosity. Remember that people learn new ideas quickly when you can relate it to something they already know or have experience with. And if you can do it elegantly through a story, it will come off as polished and professional. Here's an example:

> You see people wandering by, stopping in front of the board. Step up to them and ask: "What about my display caught your eye?"
>
> After they mention or point to something, you can start talking *briefly* about it, preferably with some snippet that will peak their interest. For instance: "Yes, that's the time it flew onto the roof. I had to retake that set of data, though. Let me know if you have any questions."
>
> If they have more questions, and ask about how your rocket works, you can say:
>
> "I'll bet you already know the most important parts about rocket science. Here, let me know you how you already know the Universal Laws of Physical Motion…" and pull out an un-inflated balloon as you continue:
>
> "If I blow this up, and hold it here in my fingers, which way will the balloon go when I release it?" They point one direction.
>
> "Which way will the air inside the balloon go?" They point in the other direction.
>
> "That's right – equal and opposite. The third law is "for every action, there is an equal and opposite reaction'. A rocket works the same way. The flames come out this side (point to the engine), and the rocket goes this way. See? You're practically a rocket scientist yourself!"

The Formal Presentation The second talk is the one you'll need to spend time on. This is the place where you need to talk about everything in your report without putting the judges to sleep. Remember, they're hearing from tons of kids all day long. The more snappy and interesting you are, the more memorable you'll be.

Tips & Tricks for Presentations: Be sure to include professionalism, clarity, neatness, and 'real-ness' in your presentation of the project. You want to show the judges how you did 'real' science – you had a question you wanted answered, you found out all you could about the topic, you planned a project around a basic question, you observed what happened and figured out a conclusion.

Referring back to your written report, write down the highlights from each section onto an index card. (You should have one card for each section.) What's the most important idea you want the judges to realize in each section? Here's an example:

Research Card: How high can a chemical reaction really power a rocket? After researching streamline designs by Bernoulli to minimize drag, multi-staging ideas from Robert Goddard to increase total rocket thrust, and taking a closer look at the chemical reaction of combining baking soda and vinegar, I realized I had all the basics for making a high-flying rocket.

Question/Hypothesis Card: But how high could it really go? I hypothesized the rocket would fly the highest when the most amount of chemical reactants were inside the rocket.

Procedure/Experiment Card: Using generic effervescent tablets combined with water for the chemical reaction and a Fuji film canister for the rocket body, I ran ten trials varying the amount of water (increasing in increments of 5mL with each trial) combined with one standard effervescent tablet and measured the maximum altitude height reached using a measuring tape against a 30' high telephone pole.

Results/Conclusion Card: The data recorded did not support my hypothesis. The rocket actually flew the highest (27 feet vertically) when I combined one effervescent tablet with 12mL of water. (It actually flew the poorest when I filled the entire canister with chemical reactants, as I originally had hypothesized.)

Recommendations Card: For further study, I recommend running an experiment to test the various available water types (tap water, distilled, filtered, etc.) and also another experiment to test for the ideal water temperature that will yield the highest rocket altitude. This experiment was a lot of fun, and had unexpected results, and I learned something new!

Acknowledgements Card: I want to express my thanks to mom for driving me to the drug store three different times in one week, for my teacher who encourages me to go further than I really think I can go, and for dad for his help building model rockets that inspired me in the first place.

Putting it all together… Did you notice how the content of the cards were already in your report, in the abstract section? The written report is such a vital piece to your science fair project, and by writing it first, it makes the rest of the work a lot easier. You can do the tougher pieces (like the oral presentation) later because you took care of the report upstream.

As you practice your oral presentation, try to get your notes down to only one index card. Shuffling through papers onstage detracts from your clean, professional look. While you don't need to memorize exactly what you're going to say, you certainly can speak with confidence because you've done every step of this project yourself.

You're done! Congratulations!! Be sure to take lots of photos, and send us one! We'd love to see what you've done and how you've done it. If you have any suggestions, comments, or feedback, let us know! We're a small company staffed entirely human beings, and we're happy to help you strive higher!