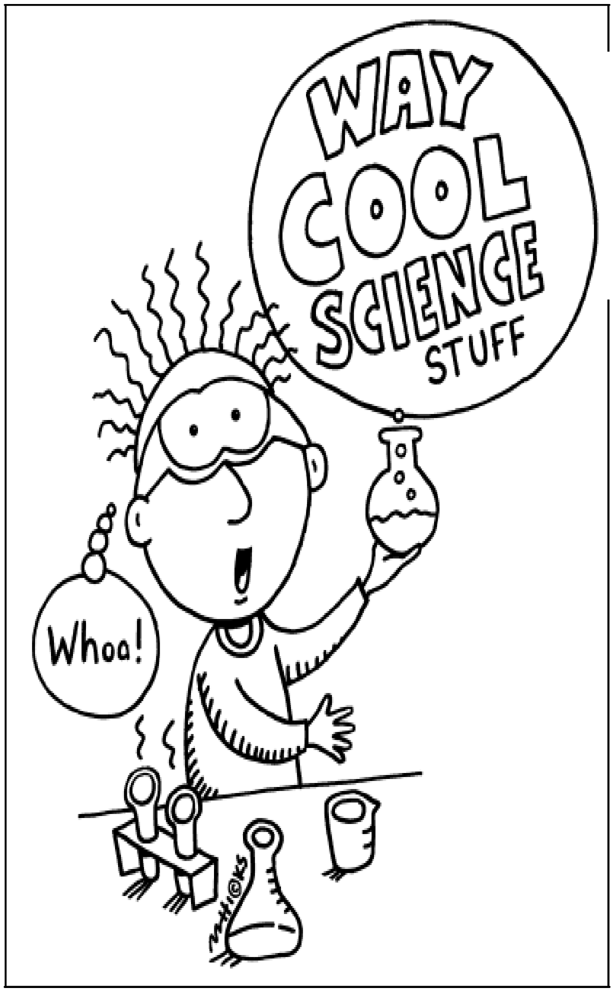
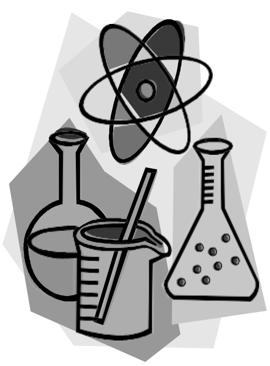
Okay, now get to work on your project!!
What's that? You still need help getting started?



Introducing
The Most Fabulous, Scientific, All Helpful,
Kid Friendly and Most Excellent
Project Planner Known to Kid Kind:

McMillan Elementary STEM Fair Planning Guide

Just follow these easy steps and you too can create a wonderful award winning project, thought up entirely by you!!!



My name is ________________

This project is due ________________

The Elementary STEM Fair Planning Guide

Table of Contents

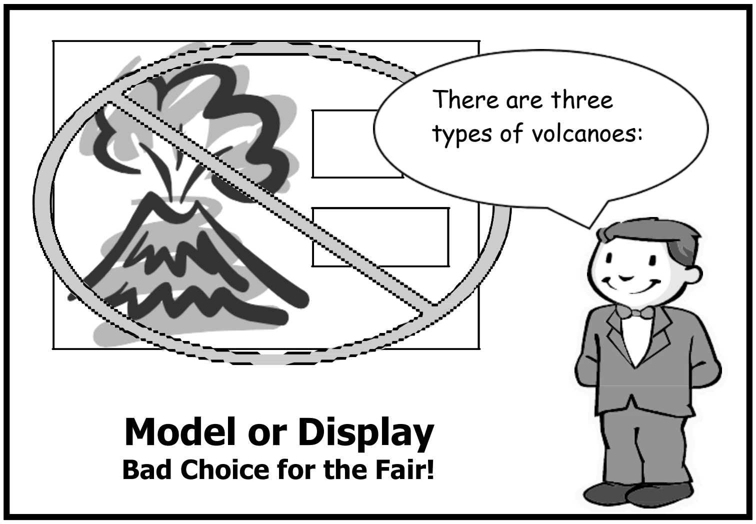
-Or-

What is inside this packet in case you are impatient and you want to jump around

Types of Projects:

There are two types of projects: Models and Experiments. Here is the difference between the two:

BORING !!!!!
DON'T DO THIS……

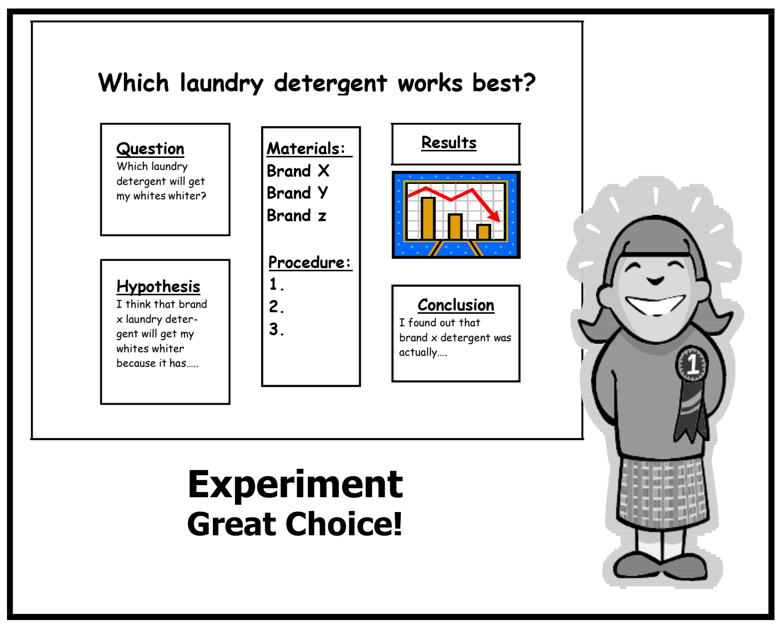


A Model, Display or Collection:

Shows how something works in the real world, but doesn't really test anything

Examples of display or collection pro- jects can be: "The Solar System", "Types of Dinosaurs" , "Types of Rocks", "My gum collection…" Exam- ples of models might be: "The solar system" or "How an Electric Motor Works", "Tornado in a Bottle"

COOL!!!!! DO THIS



An Experiment:

Lots of information is given, **but it also has a project that shows testing being done and the gathering of data.**

Examples of experiments can be: "The Effects of Detergent on the Growth of Plants", "Which Paper Towel is more Absorbent" or "What Structure can Withstand the Most Amount of Weight"

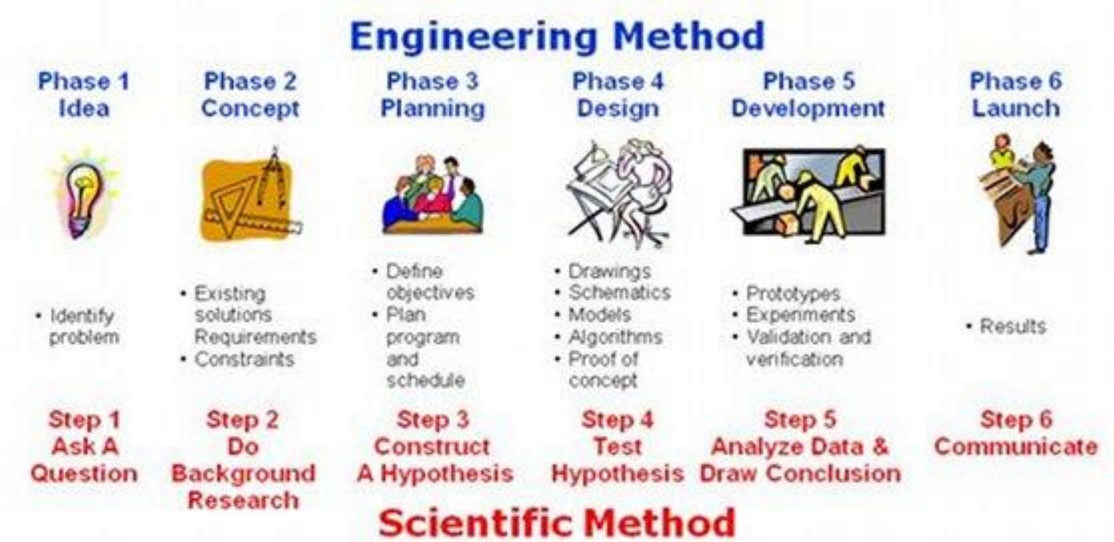
You can tell you have an experi- ment if you are testing something several times and changing a variable to see what will happen. We'll talk about variables later….

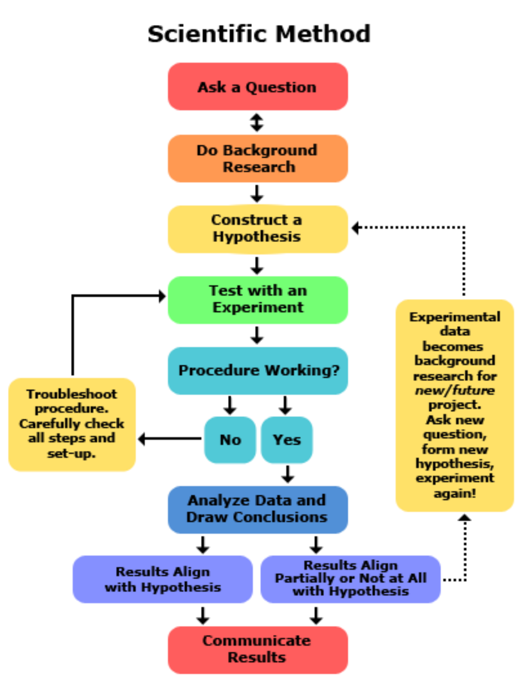
So What Type of Project Should You Do?

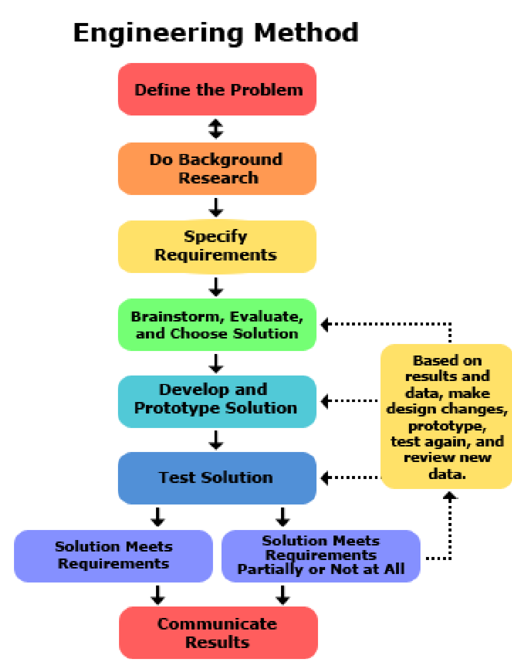
Even though you can learn a lot from building a model or display, we recommend instead using the **SCIENTIFIC METHOD OR ENGINEERING DESIGN PROCESS.**

SCIENTIFIC METHOD OR ENGINEERING DESIGN PROCESS?

While scientists study how nature works, engineers create new things, such as products, websites, environments, and experiences. Because engineers and scientists have different objectives, they follow different processes in their work. Scientists perform experiments using the **scientific method**; whereas, engineers follow the creativity-based **engineering design process**. If your project involves making observations and doing experiments, you should probably follow the Scientific Method. If your project involves designing, building, and testing something, you should probably follow the Engineering Design Process.







Reference Engineering Design Process https://sites.tufts.edu/eeseniordesignhandbook/2013/engineering-method/
Reference text and images: www.sciencebuddies.org

The Scientific Method	The Engineering Design Process
State your question	Define the problem
Do background research	Do background research
Formulate your hypothesis, identify variables	Specify requirements
Design experiment, establish procedure	Create alternative solutions, choose the best one and develop it
Test your hypothesis by doing an experiment	Build a prototype
Analyze your results and draw conclusions	Test and redesign as necessary
Communicate results	Communicate results

Choosing a category that interests you…

All Great Projects start with great questions but before you get started on a great question you need to pick a subject or topic that you like. There are many categories to learn about!

- Behavioral & Social Sciences
- Biology & Biochemistry
- Chemistry
- Earth & Environmental Sciences
- Energy: Chemical & Physical
- Engineering: Civil & Environmental
- Engineering: Electrical & Computer Science
- Engineering: Materials & Biomedical
- Engineering: Mechanical
- Medicine & Health Sciences
- Physics, Astronomy, & Math
- Plant Sciences

Visit www.sciencebuddies.org to take a quiz on your grade level and your interests that will help with project ideas.

Now it's Your Turn:

Write down your favorite category and what it is you want to learn more about:

My favorite category was ______________________________

I want to do an experiment or create a solution involving:

____

____

____

____

Step 1: Coming up with a Good Question or Defining the Problem…

Now that you have picked out a topic that you like and that you are interested in, it's time to write a question or identify a problem within that topic. To give you an idea of what we mean you can start off by filling in the question blanks with the following list of words:

The Effect Question:

What is the effect of________________on________________________?

sunlight the growth of
eye color pupil dialation
brands of soda a piece of meat
temperature the size of a balloon
oil a ramp

The Design Question:

___________________need___________because _____________________?

people alarm clocks waking up
children robots cleaning rooms
patients vitamins health
pets tracker collars safe

The Which/What and Verb Question

Which/What__________________________(verb)__________________________?

paper towel is most absorbent foods
do meal worms prefer
detergent makes the most bubbles paper
towel is strongest peanut
butter tastes the best

<u>Now it's your turn:</u>

Create your question:____

____

____

Step 2: Doing the Research

So you've picked your category and you've chosen a topic. Now it is time to research your problem as much as possible. Becoming an expert at your topic is what real scientists do in real labs.

So how do you become an expert?

YOU READ!!!!

READ about your topic. READ encyclopedias. READ magazine articles and books from the library. READ articles from the internet. Take note of any new words you learn and use them.

YOU DISCUSS!!

Talk about it with your parents. Talk about it with your teachers. Talk about it with experts like Veterinarians, Doctors, Weathermen or others who work with the things you are studying.

Whew.....Then when you think that you can't possibly learn anymore you are now ready to...

<table>
<tr><th>SCIENTIFIC METHOD</th><th>ENGINEERING DESIGN PROCESS</th></tr>
<tr><td>Write a Hypothesis</td><td>Write your Design Brief</td></tr>
<tr><td>Now it is the time to PREDICT what you think will happen if you test your problem. This type of "SMART GUESS" or PREDICTION is what real scientists call A HYPOTHESIS. *What do you think will happen when you conduct your experiment?*

Example Problem:
Which Paper Towel is more absorbent?

Example Hypothesis: I think Brand X will be more absorbent because it's a more popular brand, it is thicker and the people I interviewed said that the more expensive brands would work better. (This hypothesis not only predicts what will happen in the experiment, but also shows that the "Scientist" used research to back up the prediction.)</td><td>Now it is time to write out your design for your solution. A design brief gathers all the key information for solving your problem. It should contain:

• A definition of the <u>problem</u> you intend to solve. [Who] need(s) [what] because [why].
• A description of how existing products are used and why they fail to address the problem.
• A description of who you want to use this solution.
• A list of all the requirements for your design or solutions. For example:

Example: Can I create a better grocery store bag that is cheaper to use than plastic or paper bags?

Example Requirements: Based on your problem statement, a successful bag would use less expensive material than existing bags and function properly as a grocery bag. Examples of some of your design requirements might be that the bag needs to:
• Have handles so that shoppers can carry multiple bags
• Hold up to five pounds of food without breaking.
• Cost less than five cents to make.
• Collapse so that it can be stored at grocery stores.

Review more examples here:
http://www.sciencebuddies.org/engineering-design-process/design-requirements-examples.shtml</td></tr>
</table>

Now it's your turn:

Question or Problem to Solve:____

____

Research: My problem is about this subject: ______________________________ (sample topics could be magnetism, electricity, buoyancy, absorbency, taste, plant growth, simple machines or other scientific topics that relate to your problem. If you are having problems finding out what the topic is, ask your teacher or an adult to help you on this one….)

Books I found in the library on my topic are:
Title: Author:

____

____

____

Internet sites that I found on my topic are:

____

____

____

People I talked to about my topic are:

____

____

____

Some important points that I learned about my topic are

- ____
- ____
- ____
- ____

Hypothesis (Scientific Method) OR Possible Solution (Engineering Process:
I think that____

(will happen) because (my research shows…)______________________________

____

____

Step 3: Using the…

Scientific Method	Engineering Design Process
Testing your Hypothesis by doing an experiment Now we've come to the good part. The part that all scientists can't wait to get their grubby little hands on… you guessed it… The EXPERIMENT! Designing an experiment is really cool because you get to use your imagination to come up with a test for your problem, and most of all, you get to prove (or disprove) your Hypothesis. **Fair Rules state that <u>you cannot perform your experiment live</u>, so you'll have to take plenty of pictures as you go through these seven very simple steps.** First: ***<u>Gather up your materials</u>***: What will you need to perform your experiment? The safest way to do this is get that adult you recruited to help you get the stuff you need. Oh, did we mention to take pictures or draw pictures of your materials. This will come in handy when you are making your board display. Second: ***<u>Write a PROCEDURE.</u>*** A procedure is a list of steps that you did to perform an experiment. Why do you need to write it down? Well it's like giving someone a recipe to your favorite dish. If they want to try it, they can follow your steps to test if it's true. Scientists do this so that people will believe that they did the experiment and also to let other people test what they found out. Did we mention to take pictures of yourself doing the steps? Third: ***<u>Identify your variables.</u>*** The variables are any factors that can change in an experiment. Remember that when you are testing your experiment you should only **test one variable at a time** in order to get accurate results. In other words, if you want to test the affect that water has on plant growth, then all the plants you test should be in the same conditions, these are called	**Building and Testing** Now it's time to BUILD YOUR SOLUTION and test to see if it works! First: ***<u>Gather up your materials</u>***: What will you need to create your solution? The safest way to do this is get that adult you recruited to help you get the stuff you need. Oh, did we mention to take pictures or draw pictures of your materials. This will come in handy when you are making your board display. Second: ***<u>Now that you have your requirements and the design, it's time to build your solution!</u>*** The #1 Rule when creating solutions: **DON'T SETTLE FOR YOUR FIRST IDEA!** Good designers try to generate as many possible solutions as they can before choosing one that they feel is the best. Visit this page for a great worksheet about your solution and alternatives: http://www.sciencebuddies.org/engineering-design-process/engineering-design-decision-matrix-worksheet.pdf Third: ***<u>TEST, REDESIGN, TEST</u>***. So now it's time to finally test out your solution! Remember that the judges expect your results to be consistent in order to be a good experiment, in other words, when you cook from a recipe you expect the outcomes to be the same if you followed the directions (or procedure) step by step. So that means you need to do the experiment more than once in order to test it properly. We recommend five times or more. <u>More is better</u>! Don't forget to take pictures of the project being done and the results. ***WAIT! Maybe your solution didn't quite work?*** Remember those other ideas you had about alternate solutions? It

controlled variables: same type of dirt, same type of plant, same type of location, same amount of sunlight, etc. The only variable you would change from plant to plant would be the amount of water it received. This is called the **independent or manipulated variable.** The independent variable is the factor you are testing. The results of the test that you do are called the **dependent or responding variables.** The responding variable is what happens as a result of your test. Knowing what your variables are is very important because if you don't know them you won't be able to collect your data or read your results.

Fourth: ***TEST, TEST, TEST.*** Remember that the judges expect your results to be consistent in order to be a good experiment, in other words, when you cook from a recipe you expect the outcomes to be the same if you followed the directions (or procedure) step by step. So that means you need to do the experiment more than once in order to test it properly. We recommend five times or more. More is better! Don't forget to take pictures of the project being done and the results.

Fifth: ***Collect your DATA.*** This means write down or record the results of the experiment every time you test it. You also need to organize it in a way that it is easy to read the results. Most scientists use tables, graphs and other organizers to show their results. Organizing makes the results easy to read, and much easier to recognize patterns that might be occurring in your results. (Besides, it impresses the judges when you use them.) But don't make a graph or table because we asked you to, use it to benefit your project and to help you make sense of the results. There is nothing worse than having graphs and tables that have nothing to do with answering the question of a project.

might be time to redesign and then re-test. Remember this great spreadsheet to help keep track of your changes and progress: http://www.sciencebuddies.org/engineering-design-process/engineering-design-decision-matrix-worksheet.pdf

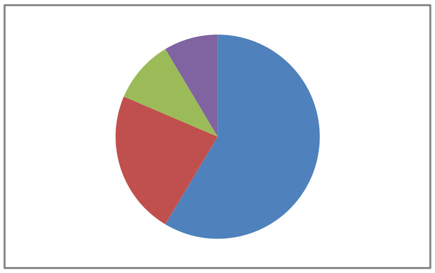
Fourth: ***Collect your DATA.*** This means write down or record the results every time you test it. You also need to organize it in a way that it is easy to read the results. Most scientists use tables, graphs and other organizers to show their results. Organizing makes the results easy to read, and much easier to recognize patterns that might be occurring in your results. (Besides, it impresses the judges when you use them.) But don't make a graph or table because we asked you to, use it to benefit your project and to help you make sense of the results. There is nothing worse than having graphs and tables that have nothing to do with answering the question of a project.

Time out: How Do You Collect Data?!!?

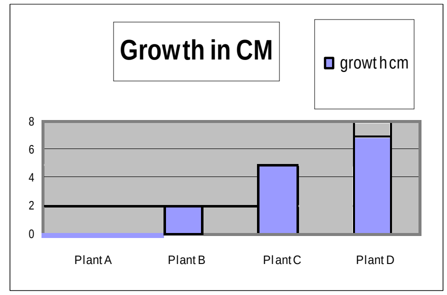
- **Keep a journal:** A journal is a type of diary that you can keep especially if your experiment is taking place over a long period of time. We suggest you do that if your experiment is over a period of a week or more. In your journal you can record observations, collect research, draw and diagram pictures and jot down any additional questions you might have for later.
- **Have the right tools to do the job:** make sure you have the stuff you need to take accurate measurements like rulers, meter tapes, thermometers, graduated cylinders or measuring cups that measure volume. The recommended standard of measurement in is metric so if you can keep your measurements in meters, liters, Celsius, grams, etc, you are doing great!
- **Tables, charts and diagrams** are generally the way a good scientist like you would keep track of your experiment trials. Remember you are testing at least 5 times or more. A table is organized in columns and rows and **ALWAYS** has labels or headings telling what the columns or rows mean. You will probably need a row for every time you did the experiment and a column telling what the independent variable was (what you tested) and the responding variable (the result that happened because of the independent variable)

Plant	Amount of water per day	Size it grew in two weeks
(controlled variable)	(independent variable)	(responding variable)
Plant A	none	.5 cm
Plant B	5 ml	2 cm
Plant C	10 ml	5 cm
Plant D	20 ml	7 cm

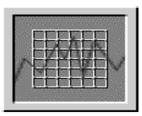
- **Be accurate and neat!** When you are writing your tables and charts please make sure that you record your data in the correct column or row, that you write neatly, and most of all that you record your data as soon as you collect it **SO YOU DON'T FORGET WHAT HAPPENED!!!!** Sometimes an experiment might be hard to explain with just a table, so if you have to draw and label a diagram (or picture) to explain what happened, it is recommended that you do.
- **Use the right graph for your experiment**. There is nothing worse than a bad graph. There are all types of graph designs, but these seem to be easy to use for fair experiments.
    - **Pie graphs** are good to use if you are showing percentages of groups. Remember that you can't have more than 100% and all the pieces need to add up to 100%. This type of graph is great if you are doing surveys.



- **Bar graphs** are good to use if you are comparing amounts of things because the bars show those amounts in an easy to read way. This way the judges will be able to tell your results at a glance. Usually the bars go up and down. The x axis (or horizontal axis) is where you label what is being measured, (like plant A, B, C and D) and the y axis (or vertical axis) is labeled to show the unit being measured (in this case it would be centimeters that the plant grew)



- **Line graphs** are good to use if you are showing how changes occurred in your experiments over time. In this particular case you would be using the x axis to show the time increments (minutes, hours, days, weeks, months) and then you would use the Y axis to show what you were measuring at that point in time.



Finally! ***Write a Conclusion:*** Tell us what happened. Were you successful, did it turn out okay? Would you change anything about the experiment or are you curious about something else now that you've completed your experiment. And most of all, **TELL WHAT YOU LEARNED FROM DOING THIS.**

Understand its Application. Write about how this experiment can be used in a real life situation. Why was it important to know about it?

Now it's your turn

Materials (Take pictures!)

List the Materials that you will need here:

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________

Variables: **(SCIENTIFIC METHOD)**

List the variables that you will control, the variable that you will change and the variables that will be the results of your experiment. My controlled variables are (the stuff that will always stay the same):

____

____

My independent variable is (this is the thing that changes from one experiment to the next, it is what you are testing):

____

____

My responding variables might be (in other words, the results of the experiment)____

Procedure: List the steps that you have to do in order to perform the experiment here:

1.____

2. ____

3. ____

4. ____

5. ____

Design a table or chart here to collect your information

(Did we mention that you needed to take pictures of you doing the actual experiment?)

Conclusion:

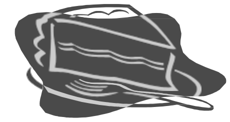
Now tell us what you learned from this. Did it work? Why did it work or why didn't it work? What did the results tell you? Sometimes not being able to prove a hypothesis OR create a solution is important because you still proved something. What did you prove?

Application:

(How does this apply to real life?)

It's important to know about this experiment because……

Step 4: The Presentation or Why you needed all those pictures….



A good display is a Piece o'cake

But First, a school fable….
Sammy and Sally both baked cakes for the bake sale with the same cake mix and by following the same directions. When Sammy got his cake out of the oven, he carefully took it out of the pan, smoothed the chocolate frosting neatly and decorated his cake so that it looked delicious. Sally on the other hand, smashed her cake slightly when getting it out of the pan and globbed the frosting on parts of the cake. As you may have already guessed, everyone wanted some of Sammy's cake and no one wanted Sally's. Sally couldn't figure out why, because she tasted both and they both tasted the same…

You may have become the leading expert of your topic and had the most interesting experiment results, but if you don't make your project look delicious for the judges eyes to see, well, your chances of winning sweep stakes will crumble like Sally's cake. Your display board is kind of like an advertisement for all your hard work. So take our advice: **BE NEAT!!** The judges like to see a nice, easy to read display, that has neat writing, easy to read graphs and tables and you guessed it…. lots and lots of pictures!! (Did you remember to take pictures?)

Visit this site for Project Display Layout:
http://www.sciencebuddies.org/blog/2012/03/perfecting-the-project-display-board.php

********IMPORTANT: PROJECTS WILL BE PRESENTED IN POSTER FORMAT. NO ACTUAL PROJECTS/MATERIALS/SOLUTIONS WILL BE DISPLAYED.********

Fair Rules and Regulations

Aw!, you mean there are rules? Of course there are, silly, this is made by adults!

Safety Rules First

1. Number one rule… think safety first before you start. Make sure you have recruited your adult to help you.
2. Never eat or drink during an experiment and always keep your work area clean.
3. Wear protective goggles when doing any experiment that could lead to eye injury.
4. Do not touch, taste or inhale chemicals or chemical solutions.
5. Respect all life forms. Do not perform an experiment that will harm an animal.
6. All experiments should be supervised by an adult!
7. Always wash your hands after doing the experiment, especially if you have been handling chemicals or animals.
8. Do not grow any microorganisms (i.e. bacteria).
9. Any project that involves drugs, firearms, or explosives are not permitted.
10. Any project that breaks district policy, and/or local, state or federal laws are not permitted. (Read more about this regulations via the school STEM Fair website page.)
11. Use safety on the internet! Never write to anyone without an adult knowing about it. Be sure to let an adult know about what websites you will be visiting, or have them help you search.
12. If there are dangerous aspects of your experiment, like using sharp tools or experimenting with electricity, please have an adult help you or have them do the dangerous parts. That's what adults are for, so use them correctly. (Besides, it makes them feel important!)

Fair Rules

1. Teams or individual projects must be approved by your teacher.
2. Adults can help, in fact we want them to get involved. They can help gather materials, supervise your experiment and even help build the display. They just can't be with you during the judging. (So parents, no peeking!)
3. Experiments or solution testing are required for these projects. Please, no collections or models. You will be judged on the use of the Scientific or Engineering Method (we told you that on page 2.)
4. You cannot bring the materials of your experiment for the display or perform the experiment live. You will only be judged on your presentation and board. You can however, mount things on your board in a type of 3D display, but remember that your board has to be able to stand by itself, so don't get carried away. If you do mount things on the board, try not to mount something expensive that you bought and make sure you have things mounted securely so they don't fall off. YOU MAY NOT MOUNT ANY FOOD OR ORGANIC MATERIALS!
5. Displays must be on display boards or can be made with cardboard. They must stand alone. See the display example link on the previous page if you need a diagram.
6. Respect all adults involved in the fair… especially the judges!
7. All decisions of the judges and fair committee are final.