**The Scientific Method**

**The Process and The Journal**

Every step of the scientific method should be included in the journal.

**Your Journal Should Contain the Following Sections:**

1. Title Page
2. Table of Contents
3. Abstract
4. Purpose: What Question are you trying to answer?
5. Background Research
6. Hypothesis
7. Experiment: Materials, Variables and Procedure
8. Data- this should include tables with raw data
9. Analysis- this includes a graph
10. Conclusion
11. Bibliography

The outline of what is required for each step in the scientific method follows:

**1. Title Page**

The title page consists of the project title, student, name, school and date

**2. The Table of Contents**

The table of contents should include the steps to the scientific method with page numbers so the topics are easily found.

**3. Abstract 250 words or less**

•**Introduction**. This is where you describe the purpose for doing your science fair project or invention. Why should anyone care about the work you did? You have to tell them why. Did you explain something that should cause people to change the way they go about their daily business? If you made an invention or developed a new procedure how is it better, faster, or cheaper than what is already out there? **Motivate** the reader to finish the abstract and read the entire paper or display board.

•**Problem Statement**. Identify the problem you solved or the hypothesis you investigated.

•**Procedures**. What was your approach for investigating the problem? Don't go into detail about materials unless they were critical to your success. Do describe the most important variables if you have room.

•**Results**. What answer did you obtain? Be specific and use numbers to describe your results. Do not use vague terms like "most" or "some."

•**Conclusions**. State what your science fair project or invention contributes to the area you worked in. Did you meet your objectives? For an engineering project state whether you met your design criteria.

 **Things to Avoid**

•Avoid jargon or any technical terms that most readers won't understand. • Avoid abbreviations or acronyms that are not commonly understood unless you describe what

they mean.

•Abstracts do not have a bibliography or citations.

•Abstracts do not contain tables or graphs..

•If you are working with a scientist or mentor, your abstract should only include procedures done by you, and you should not put acknowledgements to anyone in your abstract.

**Why Is an Abstract Important?**

 Your science fair project abstract lets people quickly determine if they want to read the entire report. Consequently, at least ten times as many people will read your abstract as any other part of your work. It's like an advertisement for what you've done. If you want judges and the public to be excited about your science fair project, then write an exciting, engaging abstract!

 Since an abstract is so short, each section is usually only one or two sentences long. Consequently, every word is important to conveying your message. If a word is boring or vague, refer to a thesaurus and find a better one! If a word is not adding something important, cut it! But, even with the abstract's brief length, don't be afraid to reinforce a key point by stating it in more than one way or referring to it in more than one section.

**4. Background Research and Information:**

**STEP #1 – REASONS FOR CHOOSING YOUR TOPIC**

Now that you have selected a topic, write in your journal in a section that you title "Background Research" your reason(s) for choosing the topic you chose or the purpose of your investigation. **Also, write in your journal what you already know about your topic.**

**STEP #2 – INFORMATION RELATED TO YOUR TOPIC**

Now that you have selected a topic and question, you'll need to find out what is already known about the subject. You will want to know information about the specifics of your topic as well as different things that could be related to your project.

For example, let's say you are interested in how oil spills affect sea creatures, such as clams. Not only will you want to research the properties of oil and the life cycle of clams, but you may also need to understand a little more about wave patterns, ocean currents and tides. In addition, you may also want to research other substances that could affect clam growth or what can be done to prevent or clean up oil spills.

**\*\*IN YOUR SCIENCE JOURNAL, LIST FIVE OR MORE RESEARCH TOPICS RELATED TO YOUR QUESTION. \*\***

**STEP #3 -- Research**

You should consult at least 5 references regarding your project. More is better. Set up a bibliography section in your journal to keep track of your reference sources. See the How to Do a Bibliography page later in this packet. **Take notes from at least four of these books or articles in your journal.** DO NOT JUST RELY ON THE INTERNET. If you use information from the internet, make sure it is from a reputable website, such as one connected to a university. Ask the librarian for help in finding science magazine articles and books relating to your topic.

**STEP #4 -- FINDING EXPERTS**

Make a list in your journal of people that might be able to help you. Talk to your teacher and to experts on your subject. Write letters, make phone calls, do whatever it takes to find out more information regarding your project before you begin experimentation. Take notes in your journal and be sure to record the person's name that you talked to, as well as the date and time.

**5. Making Your Hypothesis:**

After doing background research about your topic and understanding about your independent and dependent variables, you must make a hypothesis, or an educated guess about how the experiment will turn out. The hypothesis is normally one sentence (not a question) that states what you think the answer to the problem statement will be based on what you learned in your background research. One way to write your hypothesis in an "If.... then....because" statement. i.e.: If the independent variable is changed, then the dependent variable will change this way because...

***For example****:* **If** candy bars in a store are displayed at eye level, **then** they will sell better than those at the bottom of the display case, **because** people are more likely to notice them.

**Take a stand with your hypothesis**; don't be wishy-washy. Don't say "If candy bars in a store are displayed at eye level, then *I think they probably* will sell better than those at the bottom of the display case."

**6. Experiment: List of Materials, Procedure and Variables**

Once you have everything approved, you may begin your experimentation. Make sure you record all observations and measurements in your project journal. Don't assume you'll remember points and details. If you find that you need to change steps in your procedure, make sure that you make note of that in your journal.

***Writing Your Experimental Procedure:***

**The procedure is the set of steps that you will follow to conduct your experiment**. This should be detailed so that another person would be able to do the research following your directions. Leave out obvious instructions like "Gather all the materials."

**The steps of the procedure should be in numbered or bulleted form, not in a paragraph. Identify the independent variable, the dependent variables, and the control.**

Some important things to keep in mind when designing your experiment are:

**Control Group**

Most experiments need to have an appropriate "control", which is a standard to test your experimental results against. A control is a trial taken when the independent variable is missing or held constant or at a normal level.

For example, if you're studying the effects of cold air temperatures on tropical house plant growth, you will probably put some of the plants outside for some cold nights. When you take them inside to see how the cold affected their growth, you'll need to have some plants that were not exposed to the cold to compare them to. The plants that did not get exposed to the colder temperatures are considered a "control".

**Sample Size**

Your experiment will be much better designed if you have several "subjects" in your experiment. For example, in a plant experiment, be sure to have many plants in the control group and in the experimental group.

**Measurements**

Explain how you will be measuring your independent and the dependent variables.

**Materials**

List the materials needed for the experimentation.

**Trials**

Be sure to allow enough time to do many trials. The experiment should be repeated as many times as possible.

**\*\*IN YOUR PROJECT JOURNAL, WRITE DOWN THE STEPS OF THE PROCEDURE THAT YOU WILL FOLLOW TO CONDUCT YOUR EXPERIMENT. WRITE THE STEPS IN EITHER NUMBERED OR BULLETED FORM. Be sure to identify your control, and your independent and dependent variables. Also include the controlled variables (constants). They can be shown separately from the procedure.\*\***

**7. Collecting Data:**

A data table is a place to record your observations. Columns, with headings, must be included for the control group and the experimental group. This should be what you measured.

**8. Analysis / Results - Graph:**

Analyze your data to see if there are any important findings that have to do with your hypothesis. Briefly describe what your data shows. Compare each of the data tables and graphs of the experimental and control groups. A graph is a picture of your data and must be labeled correctly. The independent variable goes along the x-axis and the dependent variable goes along the y-axis. Both the data table and graphs should have a title which includes the dependent and dependent variables and the units that they were measured in.

**9. Writing Your Conclusion:**

The conclusion should be written in paragraph form, using complete sentences. The conclusion should let the reader know what the investigation is about, what the hypothesis is, and whether or not the hypothesis is supported by the data. In your conclusion:

• Restate the purpose or problem statement of the project.

• Restate the hypothesis.

• Use the analysis of the results to explain if the hypothesis was or was not supported by

the data. If the hypothesis was not supported by the data, explain what you think happened.

• Discuss other factors that might have affected the results.

• Discuss errors made in the project and how the experiment might be improved upon.

• Discuss interesting questions that your results lead you to ask: what, if any, implications might this experiment have in the real world?

• What might your next steps be? Could you expand on this project?

**10. Writing a Bibliography:**

Any books, newspapers, magazines, encyclopedias, online websites, or interviews that you used in your project must be acknowledged in a bibliography. This also includes any non-copyrighted photos or drawings that someone else did. Every source that you used should be cited whether you quote them directly or not.

The MLA format should be used in making your bibliography. You may get a more complete list of MLA format examples at www.easybib.com.