Science Project

Information Packet

2014 – 2015

Suggested Project Time Line

Information meeting	December 5
Confirm ideas and write hypothesis	December 8 – 12
Begin research, write glossary, and write bibliography	December 15 – 19
Write procedure, set up experiment, and collect data	December 19 – January 16
Finalize results and conclusion	January 23
Finalize research report	February 2
Finalize display board	February 18

Actual Science Fair Dates

Display Board set up (Woodcrest JHS)	February 23
Science Fair Judging (Woodcrest JHS)	February 24
Science Fair Awards Ceremony (Woodcrest JHS)	February 25
County Science Fair Registration for CVUSD winners	February 27
County Science Fair Judging and Awards	April 6 – 7
State Science Fair	April 27 – 28

Purpose of the Project (Answer a question or test a prediction)

- The scientific method is a way to ask and answer scientific questions by making observations and doing experiments.
- The steps of the scientific method are to:
    - **Ask a Question**
    - **Do Background Research**
    - **Construct a Hypothesis**
    - **Test Your Hypothesis by Doing an Experiment**
    - **Analyze Your Data and Draw a Conclusion**
    - **Communicate Your Results**
- It is important for your **experiment** to be a fair test. A "fair test" occurs when you change only one factor (variable) and keep all other conditions the same.

- While scientists study how nature works, engineers create new things, such as products, websites, environments, and experiences
- Once you find a general topic that interests you, write down the question that you want to answer. A scientific question usually starts with: How, What, When, Who, Which, Why, or Where. For example, if you are interested in robots, your question might be "How much current does a robot's arm use to lift a weight?"
- Can you design a fair test to answer your question? A "fair test" requires that you change only one factor (variable) and keep all other conditions the same. If you cannot design a fair test, then you should change your question.
- Your science fair project question should involve factors or traits that you can easily measure using a number (or factors or traits that are easily identified, like colors).

Keeping a Journal or Lab Notebook

Whether you are a research scientist, an engineer, or a first-time science fair student, you should use a lab notebook to document your science investigations, experiments, and product designs. A lab notebook is an important part of any research or engineering project. Used properly, your lab notebook contains a detailed and permanent account of every step of your project, from the initial brainstorming to the final data analysis and research report. Many science projects require a number of steps and multiple trials. By recording the steps of your procedure, your observations, and any questions that arise *as you go*, you create a record of the project that documents *exactly* what you did and when you did it. With a complete record of the project in your lab notebook, you can look back at your notes later if a question arises or if you decide to pursue a related project based on something you observed. Similarly, writing down your product design ideas, engineering challenges, and product testing data will help you keep track of all of your ideas, what you have already tried, and how well a particular design performed.

1. **Label your lab notebook.** Put your name, your teacher's name (if it applies), and some form of contact information, like an email address or phone number, in a prominent location, like the inside cover. If you accidentally leave the lab notebook behind or lose it, someone will be able to reach you if the notebook is found. If your notebook will be used for a single science or engineering project, also label the notebook with the project title and the year.
2. **Use ink.** Make your lab notebook entries in pen, not in pencil. Using a smudge-proof pen may reduce the risk of smears. If you make a mistake in your lab notebook, simply *cross out* the error and write in the necessary correction.
3. **Number the pages.** Numbering the pages of your lab notebook helps keep your notebook organized. You can use these numbers to set up an index or table of contents (*see below*) or to cross-reference earlier observations within your lab notebook. If the pages of your lab notebook are not already numbered, you may want to number them *before* you begin using the lab notebook.

4. **Create a table of contents.** To quickly go back and find information in your lab notebook, it helps to create a table of contents. The traditional way (used by professional scientists and engineers) is to create a Table of Contents as you go. Label the first page "Table of Contents," and then as you work on the project, enter important pages in the Table of Contents. For example, when you begin your Experimental Procedure, you might note "Trial 1, Page 10" in the Table of Contents so you can quickly find your notes at a later date.

Conducting Background Research

Background research is necessary so that you know how to design and understand your experiment. To make a **background research plan** -- a roadmap of the research questions you need to answer -- follow these steps:

1. Identify the keywords in the question for your science fair project. Brainstorm additional keywords and concepts.
2. Use a table with the "question words" (why, how, who, what, when, where) to generate research questions from your keywords. For example:

   What is the difference between a series and parallel circuit?
   When does a plant grow the most, during the day or night?
   Where is the focal point of a lens?
   How does a java applet work?
   Does a truss make a bridge stronger?
   Why are moths attracted to light?
   Which cleaning products kill the most bacteria?

   Throw out irrelevant questions.

3. Add to your background research plan a list of mathematical formulas or equations (if any) that you will need to describe the results of your experiment.
4. You should also plan to do background research on the history of similar experiments or inventions.
5. Network with other people with more experience than yourself: your mentors, parents, and teachers. Ask them: "What science concepts should I study to better understand my science fair project?" and "What area of science covers my project?" Better yet, ask even more specific questions.
6. Most teachers will require you to find at least three sources of information.

7. How to find information:

   a. Find and read the general information contained in an encyclopedia, dictionary, or textbook for each of your keywords.
   b. Use the bibliographies and sources in everything you read to find additional sources of information.
   c. Search periodical indexes at your local library.
   d. Search the Internet to get information from an organization, society or online database.
   e. Broaden your search by adding words to your search phrases in search engines. Narrow your search by subtracting words from or simplifying your search phrases.

8. When you find information, evaluate if it is **good** information:
9. Make a list to keep track of ALL the books, magazines, and websites you read as you follow your background research plan. Later this list of sources will become your **bibliography**.

10. Most teachers want you to have at least three written sources of information.

11. Write down, photocopy, or print the following information for each source you find. You can use the Bibliography Worksheet to help you.
12. As you do your research, follow your background research plan and take notes from your sources of information. These notes will help you write a better summary.

13. The purpose of your **research paper** is to give you the information to understand why your experiment turns out the way it does. The research paper should include:

    1. The history of similar experiments or inventions
    2. Definitions of all important words and concepts that describe your experiment
    3. Answers to all your background research plan questions
    4. Mathematical formulas, if any, that you will need to describe the results of your experiment

14. For every fact or picture in your research paper you should follow it with a citation telling the reader where you found the information. A citation is just the name of the author and the date of the publication placed in parentheses like this: (Author, date). This is called a reference citation when using APA format and parenthetical reference when using the MLA format. Its purpose is to document a source briefly, clearly, and accurately.

15. If you copy text from one of your sources, then place it in quotation marks in addition to following it with a citation. Be sure you understand and avoid plagiarism! Do not copy another person's work and call it your own. Always give credit where credit is due!

16. Most teachers want a research paper to have these sections, in order:

1. Title page (with the title of your project, your name, school, grade level, and the date)
2. Your report (Introduction, Research, Methods, Results, Conclusion)
3. Bibliography
4. Check with your teacher for additional requirements such as page numbers and a table of contents

Constructing a Hypothesis

Scientists use an experiment to search for **cause and effect** relationships in nature. In other words, they design an experiment so that changes to one item cause something else to vary in a predictable way.

These changing quantities are called **variables**. A variable is any factor, trait, or condition that can exist in differing amounts or types. An experiment usually has three kinds of variables: independent, dependent, and controlled.

The **independent variable** is the one that is changed by the scientist. To insure a fair test, a good experiment has only one independent variable. As the scientist changes the independent variable, he or she **observes** what happens.

The scientist focuses his or her observations on the **dependent variable** to see how it responds to the change made to the independent variable. The new value of the dependent variable is caused by and depends on the value of the independent variable.

For example, if you open a faucet (the independent variable), the quantity of water flowing (dependent variable) changes in response--you observe that the water flow increases. The number of dependent variables in an experiment varies, but there is often more than one.

Experiments also have **controlled variables**. Controlled variables are quantities that a scientist wants to remain constant, and he must observe them as carefully as the dependent variables. For example, if we want to measure how much water flow increases when we open a faucet, it is important to make sure that the water pressure (the controlled variable) is held constant. That's because both the water pressure and the opening of a faucet have an impact on how much water flows. If we change both of them at the same time, we can't be sure how much of the change in water flow is because of the faucet opening and how much because of the water pressure. In other words, it would not be a fair test. Most experiments have more than one controlled variable. Some people refer to controlled variables as "constant variables."

In a good experiment, the scientist must be able to **measure** the values for each variable. Weight or mass is an example of a variable that is very easy to measure. However, imagine trying to do an experiment where one of the variables is love. There is no such thing as a "love-meter." You might have a **belief** that someone is in love, but you cannot really be sure, and you would probably have friends that don't agree with you. So, love is not measurable in a scientific sense; therefore, it would be a poor variable to use in an experiment.

- A hypothesis is an educated guess about how things work.
- Most of the time a hypothesis is written like this: "If _____[I do this] _____, then _____[this]_____ will happen." (Fill in the blanks with the appropriate information from your own experiment.)

- Your hypothesis should be something that you can actually test, what's called a **testable** hypothesis. In other words, you need to be able to measure both "what you do" and "what will happen."

Testing Your Hypothesis by Doing an Experiment

- Write the **experimental procedure** like a step-by-step recipe for your science experiment. A good procedure is so detailed and complete that it lets someone else duplicate your experiment exactly!
- **Repeating a science experiment is an important step** to verify that your results are consistent and not just an accident.
    - For a typical experiment, you should plan to repeat it at least three times (more is better).
    - If you are doing something like growing plants, then you should do the experiment on at least three plants in separate pots (that's the same as doing the experiment three times).
    - If you are doing an experiment that involves testing or surveying different groups, you won't need to repeat the experiment three times, but you will need to test or survey a sufficient number of participants to insure that your results are reliable. You will almost always need many more than three participants!

Materials List

What type of supplies and equipment will you need to complete your science fair project? By making a complete list ahead of time, you can make sure that you have everything on hand when you need it. Some items may take time to obtain, so making a materials list in advance represents good planning!

Make the materials list as specific as possible, and be sure you can get everything you need before you start your science fair project.

Conducting the Experiment

- If you haven't already, obtain a notebook to record all of your observations during your experiment.
- Before starting your experiment, prepare a **data table** so you can quickly write down your measurements as you observe them.
- Follow your experimental procedure exactly. If you need to make changes in the procedure (which often happens), write down the changes exactly as you made them.
- Be consistent, careful, and accurate when you take your measurements. Numerical measurements are best.
- Take pictures of your experiment for use on your display board if you can.
- **Review** your data. Try to look at the results of your experiment with a critical eye. Ask yourself these questions:
  - Is it complete, or did you forget something?
  - Do you need to collect more data?
  - Did you make any mistakes?

Analyzing Your Data and Drawing a Conclusion

- **Calculate an average** for the different trials of your experiment, if appropriate.
- **Make sure to clearly label** all tables and graphs. And, include the **units of measurement** (volts, inches, grams, etc.).
- Place your **independent variable on the x-axis** of your graph and the **dependent variable on the y-axis**.

Your **conclusions** summarize how your results support or contradict your original hypothesis:

- Summarize your science fair project results in a few sentences and use this summary to support your conclusion. Include key facts from your background research to help explain your results as needed.
- State whether your results support or contradict your hypothesis. (Engineering & programming projects should state whether they met their design criteria.)
- If appropriate, state the relationship between the independent and dependent variable.
- Summarize and evaluate your experimental procedure, making comments about its success and effectiveness.
- Suggest changes in the experimental procedure (or design) and/or possibilities for further study.

Communicating Your Results

At this point, you are in the home stretch. Except for writing the abstract, preparing your science fair project final report will just entail pulling together the information you have already collected into one large document.

- Your **final report** will include these sections:
    - Title page.
    - Abstract. An abstract is an abbreviated version of your final report.
    - Table of contents.
    - Question, variables, and hypothesis.
    - Background research. This is the Research paper you wrote before you started your experiment.
    - Materials list.
    - Experimental procedure.
    - Data analysis and discussion. This section is a summary of what you found out in your experiment, focusing on your observations, data table, and graph(s), which should be included at this location in the report.
    - Conclusions.
    - Ideas for future research. Some science fairs want you to discuss what additional research you might want to do based on what you learned.
    - Acknowledgements. This is your opportunity to thank anyone who helped you with your science fair project, from a single individual to a company or government agency.
    - Bibliography.
- Write the abstract section last, even though it will be one of the first sections of your final report.

- Your final report will be several pages long, but don't be overwhelmed! Most of the sections are made up of information that you have already written. Gather up the information for each section and type it in a word processor if you haven't already.

- Save your document often! You do not want to work hard getting something written the perfect way, only to have your computer crash and the information lost. Frequent file saving could save you a lot of trouble!

- Remember to do a spelling and grammar check in your word processor. Also, have a few people proof read your final report. They may have some helpful comments!

An **abstract** is an abbreviated version of your science fair project final report (maximum 250 words). The science fair project abstract appears at the beginning of the report as well as on your display board.

Almost all scientists and engineers agree that an abstract should have the following five pieces:

- **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.
- For most science fairs, the abstract must focus on the previous 12 months' research (or less), and give only minimal reference to any earlier work.
- 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!

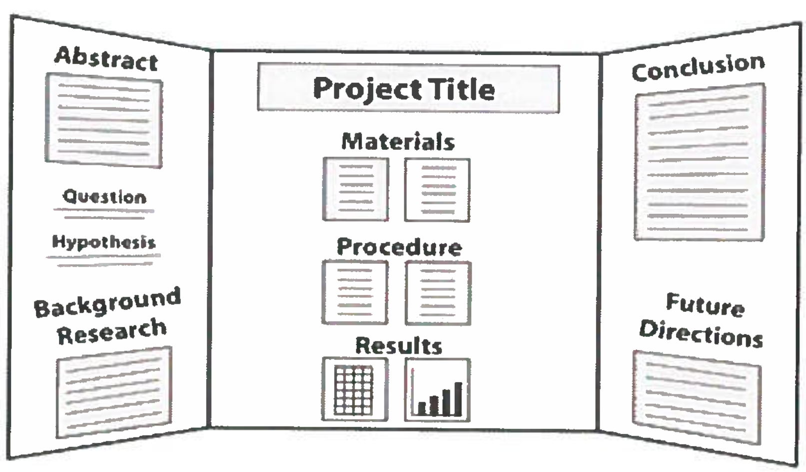
Since an abstract is so short, each section is usually only one or two sentences long. Consequently, every word is important to conveying your message. If a word is boring or vague, refer to a thesaurus and find a better one! If a word is not adding something important, cut it! But, even with the abstract's 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.

How to Meet the Word Limit

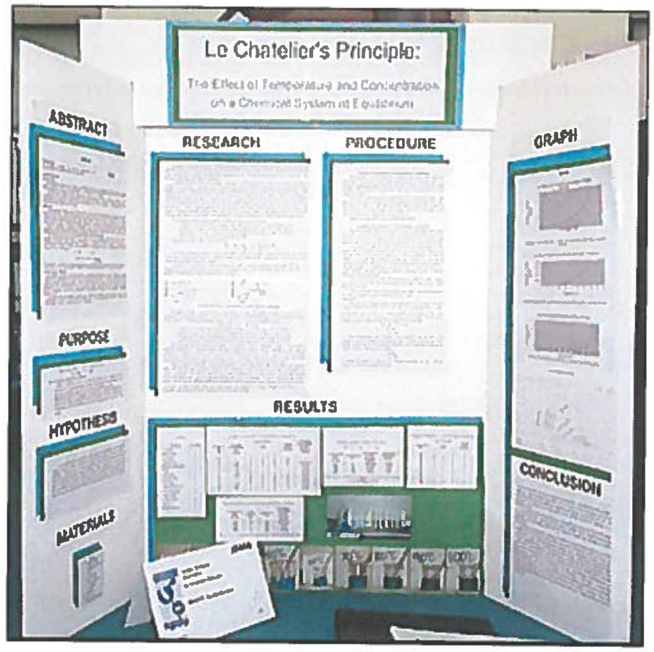
Most authors agree that it is harder to write a short description of something than a long one. Here's a tip: for your first draft, don't be overly concerned about the length. Just make sure you include all the key information. Then take your draft and start crossing our words, phrases, and sentences that are less important than others. Look for places where you can combine sentences in ways that shorten the total length. Put it aside for a while, then come back and re-read your draft. With a fresh eye, you'll probably find new places to cut. Before you know it you will have a tightly written abstract.

The Display Board

- For almost every science fair project, you need to prepare a **display board** to communicate your work to others. In most cases you will use a standard, three-panel display board that unfolds to be **36" tall by 48" wide**.



- **Organize your information like a newspaper** so that your audience can quickly follow the thread of your experiment by reading from top to bottom, then left to right. Include each step of your science fair project: Abstract, question, hypothesis, variables, background research, and so on.



- **Use a font size of at least 16 points** for the text on your display board, so that it is easy to read from a few feet away. It's OK to use slightly smaller fonts for captions on picture and tables.
- **The title should be big and easily read from across the room**. Choose one that accurately describes your work, but also grabs peoples' attention.

- **A picture speaks a thousand words!** Use photos or draw diagrams to present non-numerical data, to propose models that explain your results, or just to show your experimental setup. But, don't put text on top of photographs or images. It can be very difficult to read.

The Judging

- Preparing for **Science Fair Judging**— Practice Makes Perfect!
    - If you can communicate your science fair project well, you maximize your chances of giving a successful presentation.
    - Write up a short "speech" (about 2–5 minutes long) summarizing your science fair project. You will give this speech when you first meet the judges. (Remember to talk about the theory behind your science fair project - why your project turns out the way it does.)

- Organize a list of questions you think the judges will ask you and prepare/practice answers for them. Practice explaining your science fair project to others and pretend they are judges.
- Practice explaining your science fair project in simple terms so anyone can understand it.

- Presenting Yourself During the Science Fair Judging Period - Be Professional!
  - Always dress nicely for the science fair judging period - NO JEANS!
  - Make good use of your display board. Point to diagrams and graphs when you are discussing them.
  - Always be positive and enthusiastic!
  - Be confident with your answers; do not mumble.
  - If you have no idea what the judge is asking, or do not know the answer to their question, it is okay to say "I do not know."
  - Treat each person who visits you like a judge, even nonscientists.
  - *After* the science fair, always ask for feedback from the judges to improve your project. Many judges will ask you how you can expand your project or apply the knowledge you've gained toward future project ideas, so be prepared!