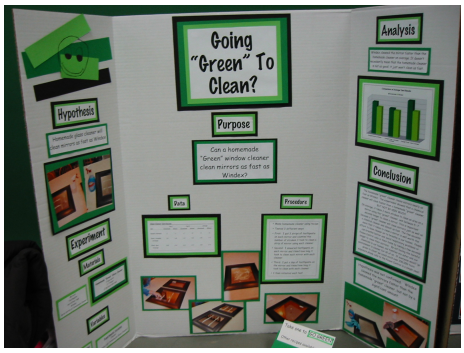
Student Engineering Design Packet (S-EDP) For 5th and 6th Grade Students



"How Does a Student Do a Meaningful Science Fair Project Using the Engineering Design Process?"

In this packet is information for students showing the steps on how to complete a meaningful science fair project using the Engineering Design Process. This packet tells what is recommended and required when students do a science fair project for the school science fair.

If you have any questions about anything ask your teacher or call Paul Nance, the Jordan District Elementary Science Teacher Specialist, at 801-244-6479 or email him at paul.nance@jordan.k12.ut.us.

Three Science Fair Processes To Choose From For A Science Fair Project

One of the major objectives of students doing a science fair project is to acquire more knowledge about the world around them. Students are able to choose from three processes, namely, the scientific method, the engineering design, and the computer design for their projects.

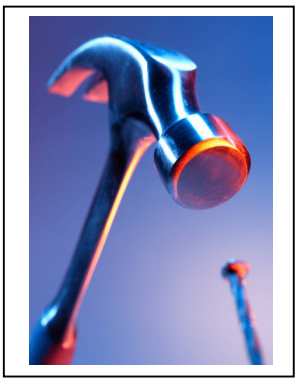
1. **The scientific method:** Using this process you will: write a question; form a hypothesis; plan an experiment; gather the materials needed; perform the experiment; examine the results; write up a conclusion showing what you learned and can apply the knowledge to real world situations.

2. **The engineering design:** Using this process you will: define a need for the product; connect the need to a design goal; establish the requirements needed for product development; write up a procedure with preliminary designs; gather the materials needed; build a prototype (a model of the product) according to the designs; test the prototype; redesign, if necessary, to meet the stated design goal; and connect or apply the value of the prototype to real world situations.

3. **The computer design:** Using this process you will: define a program need; connect the need with a design goal; establish the requirements needed for program development; write up a series of operations for the program code; develop the program with a test plan; conduct several tests according to the test plan for debugging, rewriting, and optimizing the code; and connect or apply the value of the program to real world situations.

How much work that is put into each step of one of these processes will result in a higher score on the judging sheet.

In this packet the Engineering Design will be only be presented to you. If you want the information packet on how to do a project using the scientific method or computer design processes, see your teacher.



Choosing a Topic of Interest for Your Science Fair Project Using the Engineering Design

Choosing an area of interest is the hardest part of the science fair project. For ideas as where to start, look at this engineering design science fair category and what it entails.

Engineering Design

Engineering is the designing, building, and testing of a made-at-home product. It is the invention category of the science fair. It is built according to the requirements set up by the student. After it is built it needs to be tested to see if it works. Analyze the date. If it doesn't work according to the design requirements, the student needs to go back, make adjustments, and retest. Adjustments need to be made until it works according to the stated requirements. The product results have to be useful, and it connects to real world understanding. **The prototype cannot be made from a kit.**

Here are some ideas to help you choose a topic for your science fair project using the engineering design.

airplane wings
air quality
alarms
animal tricks
blindfolding
bugs
chemical reactions
cleaning
clouds
color
computer
concentration
conservation
coordination
different age skills
dissolving
ecology
electricity
energy
environments
erosion
evaporation
feeling
food nutrition
habits
heat
heredity
inventions
light
listening
magnets
music
memory
noises
optical illusions
pH
puzzles
recycling
rockets
rocks
pollution
smelling
snowboarding
soaps
soil
soil quality
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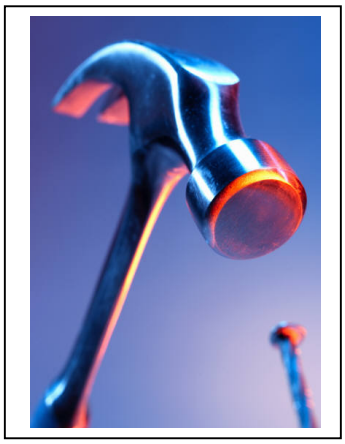
wind

The Engineering Design Outline

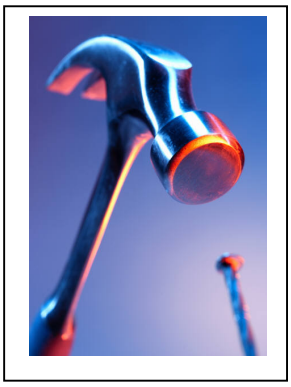


When using the Engineering Design while doing a science fair project, all of these steps listed below are required in the order shown. During the process of completing each step, each step needs to be written in your journal and later put on your display board. A judge will also ask about the engineering design process in the interview.

- **Define a Need**
- **Research**
- **Design Requirements**
- **Preliminary and Final Designs**
- **Materials Needed**
- **Step-by-step Procedure**
- **Build and Test the Prototype**
  - **Build the Prototype**
  - **Test the Prototype**
  - **Record the Data**
  - **Analyze the Data**
  - **If it doesn't work according to the "Design Requirements" then…**
- **Redesign and Retest as Necessary**
- **Conclusion**

In the next section "Procedure for the Engineering Design Process" (pages 4a-4b) gives a detailed description of what to do for each step of the engineering design process. Please read the next section carefully to know what to do for each step.

The Procedure
For The Engineering Design



A type of process students can use for a science fair project is the Engineering Design Process. The major objective is to understand the process of designing something and building a prototype (model of the product). The engineering project should be one that is a novice idea. It cannot be a purchased kit. The materials are to be raw materials found around the house and/or purchased at a store.

Students who want to build a prototype for the science fair are required to follow The Engineering Design Process described below. As students follow the Engineering Design Process, they must write about each of the following steps in a journal. **Everything that is in the journal can be questioned by the interviewer.**

1. Define a Need:

First you need a purpose for something you want to construct and to explain its purpose. It could be for a problem that needs to be solved or a situation that needs improvement. Write it so the need is clearly understood. The goal of this engineering project is to design and construct a prototype for someone to use to perform a useful function. The design goal statement for this project might be, "The goal of this project is to design, build, and test a way to minimize waiting time at stop lights in the city."

2. Research:

You need to research your topic using library materials, Internet sites, magazines, textbooks, encyclopedias, experts, and other available and reliable sources. **At least three sources must be used for the research.** A fairly lengthy paragraph should be written about each source telling what you learned. Therefore, there will be three separate paragraphs, one for each source used. Cite each paragraph where the information was found. Copying a page from a book or Internet and placing it in the journal is not research. **The research needs to be hand or type written. All that is written in the journal can be questioned by the interviewer.**

3. Design Requirements:

Next, you need to establish the requirements needed for the development of the prototype to decide how it will be built. Typical requirements relate to shape, size, weight, appearance, physical features, performance, use, cost, time and money. Another part of the design requirements is to tell the prototype expectations and how it will be tested to meet the desired expectations.

4. Preliminary and Final Designs:

- **Beginning designs**
  Here you need to draw the beginning designs of the prototype with labeled parts. They can be brainstorming designs showing two or three ideas.
- **Final designs**
  As you focus into one type of design, you need to show the changes needed as the designs get closer to the requirements and expectation of the prototype. The changed designs need to show progress from design to design.
- **List of materials**
  Make a list of all the materials and equipment you will use for building the prototype. Using descriptive words to describe the materials and equipment are important. Any materials that are measured should have the measurements listed. (Ex. wooden board 2" x 4" x 8")

- **Step-by-step procedure**
  Write a step-by-step procedure you will follow to build the prototype. Write it in the order you want to follow. Be very descriptive in your writing.

5. Build, Test and Record, and Analyze the Results of the Prototype

- **Building the prototype**
  Build a prototype according to the design requirements, drawn designs, list of supplies and equipment, and the step-by-step procedure. You need to write about the experience building the prototype.
- **Testing and record the data**
  After it is built you need to test the prototype to see if it works according to the testing procedure stated in the design requirements. You need to write down what is actually happening during the testing. You should be as descriptive as possible. Testing the prototype two or three times is important to make sure the test data is accurate.
- **Data is analyzed if redesigning is necessary**
  Analyze the data. See if the results match the design requirements. If not, redesigning is necessary.

6. Redesign, Retest and Record, and Analyze As Necessary

- After the first tests you may need to make adjustments by redesigning parts of the prototype that need adjusting. You need to show the adjustments with diagrams and labeling. Keeping accurate notes of the changes is very important in this part of the engineering project.
- Retesting is always necessary after redesigning has occurred. When you are retesting, you need to write down data as to what is happening.
- Analyze the data. See if the results match the design requirements. If not, redesigning is necessary.

(Redesigning and retesting of the prototype is the most important part of the project. Keeping notes of the changes and the results are very important. You should be able to can see at a glance what changes have been made and what happened when these changes are retested. You need to be able to recall the changes and results if needed.)

- When you feel that the prototype has reached its greatest efficiency according to the design requirements, you can then go on to the conclusion. If you feel that more designing and testing is needed, then you need to continue to redesign and retest, writing down the data until you feel the prototype is finished. The prototype needs to work and meet the design requirements.

7. Conclusion:

- When writing your conclusion you need to show evidences of what was learned. The conclusion summarizes the learning by answering some of these questions: How do the results validate what was expected to happen? What was learned from building the prototype? In what way is this prototype important? Is there more that could be done to improve the prototype? How does this prototype help people understand the world better? How can this information be applied to real life? What new insights were discovered? What knowledge was gained by designing and building something?
- The conclusion needs to show the value of the project and the prototype and how it can apply to life and/or the real world. Write about the final prototype by looking at its merits, originality, and usefulness.

Please note:

Any other project that is done by testing a product that does not involve the engineering design should be done by using the scientific process.

The Journal
For The Engineering Design

All students entering an engineering design project in the school science fair must have a journal (log). The journal is the literacy that connects the writing, thinking, research, planning, building, testing, and conclusion to engineering design project. Everything that is written in the journal can be questioned by the interviewer.

The journal consists of four main parts:

- Title page
- Table of Contents page
- The Engineering Design pages
- The Bibliography page

1. Title Page

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

2. Table of Contents

The table of contents consists of the following topics (the engineering design process) with page numbers so these topics are easily found.

- Define a need
- Research
- Design Requirements
- Project Prototype Designs
  - Beginning Prototype Designs
  - Final Prototype Designs
  - List of Materials
  - Step-by-Step Procedure
- Building, Testing and Recording, and Analyzing the Prototype
- Redesigning, Retesting and Recording, and Analyzing the Prototype
- Conclusion

3. The Engineering Design

In this section you will write what you did or discovered by following each part of the Engineering Design. See the Engineer Design pages (4a and 4b) to know what should be written on each page.

- Define a Need page
- Research page
- Design Requirement page
- Project Designs
  - Beginning Designs page
  - Final Designs page
  - List of Materials page
  - Step-by-Step Procedure page
- Building, Testing and Recording, and Analyzing the Prototype
  - Building the Prototype page
  - Testing and Recording page
  - Analysis page
- Redesigning, Retesting and Recording, Analyzing the Prototype
  - Redesigning page
  - Retesting and Recording page
  - Analysis page
- Conclusion page

4. Bibliography

Write a list of the three or more sources you used for research by telling the type of source, title, and page numbers (if applicable).

The Display Board
For The Engineering Design Process

Create a display board so your findings can be shown at the science fair. It is a summary of your project and reflects your journal. This is your showcase. Make it creative and colorful. Below are ideas for a good display board.

- Physically sound and durably constructed, able to stand by itself.
- Title of your project at the top.
- Show all the steps of the engineering design process (except the research) with a brief explanation of each: the need, design criteria, preliminary and final designs, building, testing results and the analysis, redesigning and retesting results and the analysis as needed, and the conclusion. The research will be in the journal.
- Well-organized and easy to follow from one idea to the next.
- Neat, edited, and without scribbles and misspelled words.
- Creative, pleasing to look at, colorful, with different font sizes to show emphasis.
- Photos of the developing experiment. (Only the students doing the experiment and family members can be displayed on the board. Others need parent permission if under 18 years of age.)
- Drawn pictures, artwork, and icons that bring out the ideas of the experiment.
- The journal should be in front of the display.

Students like to display items they used when doing their experiments. For reasons of safety the following items cannot be displayed at the school and district fairs. This is also found on the last page of the 2011-2012 Jordan Schools and District Science Fair Registration Form.

- Living organisms
- Plant material (living, dead, or preserved)
- Taxidermy specimens or parts
- Preserved animals including embryos
- Human or animal food including seeds
- Human or animal parts or body fluids
- Soil, sand, or waste samples
- Laboratory/household chemicals including water
- Poisons, drugs, hazardous substances or devices
- Sharp items, scissors, glass, syringes, needles
- Dry ice or other sublimating solids
- Flames or high flammable materials
- Empty tanks that previously contained combustible liquids or gases
- Batteries with open top cells
- Photographs of children under 18 other than yourself or your family without parental written permission
- Photographs or other visual presentations depicting vertebrate animals in surgical techniques, dissection, necropsies, other lab techniques, improper handling methods, improper housing conditions, etc.

Pictures of these items can be placed on the board except the last bullet.

Schools and the district have the right to remove these things above and anything else that may be dangerous to the public.

The Interview
For The Engineering Design Process

The judge's interview gives you the opportunity to explain your project. The judge wants to know how much you know about your project.

- How you received the idea
- How you personalized it to make it unique
- How you prepared it
- How you set it up
- What information you discovered
- What the information means
- What your conclusion is

The judge also wants to know your background knowledge about the subject you chose. Some of the judges' questions may not be about your project. He/she may ask questions related to your topic. For example, if you built a tsunami model to show the destruction a tsunami could cause, it would be well to know about tsunamis and the damage they can do, how they can do so much destruction, and places tsunamis have happened. Even though this information is not entirely what your project is about, it shows you have done research about tsunamis.

Some questions that might be asked:

- Explain where you got your idea for the project.
- What did you do to personalize it and make it unique?
- Explain the project method you used.
- Why did you choose this subject?
- Explain your results.
- Explain your conclusion.
- How does the result relate to your background knowledge?
- How does the result help you in understanding the world better?
- How does your project have practical applications?
- Specific background knowledge about your subject.
- What problems did you run into?
- How could you have improved your project?
- If you did it again, what would you change?
- What questions do you have now?
- Tell some ideas you learned from your research.
- How did the research help you with your project?
- How much time did you spend on your project?
- How did others help you or give you ideas?
- How did you test your prototype?

Be excited about your project when you speak. Don't talk too fast. Elaborate on your answers. Help the judge understand your project by speaking clearly in an organized manner so it's not confusing. **You need to show evidences of learning.**

Judges do not want you to redo your experiment for them. Their interest lies in your knowledge of the engineering design process, the display board, the results, and the knowledge you acquired.

5TH AND 6TH GRADES SCHOOL SCIENCE FAIR ENGINEERING JUDGING SHEET

Name(s)_____ School_____

Project Title_____

Category	Comments	Excellent 5	Good 3-4	Fair 1-2
I. Journal/Log (Engineering Design)				
Title Page/Table of Contents: Title, name, school, date, and the table of contents				
Need: A need for the project is defined				
Research: Three different sources cited with well-written notes				
Design Requirements: Clear statement of the requirements for prototype development				
Preliminary and Final Designs: o Beginning and final designs drawn and labeled showing changes to meet the design requirements				
o Materials' list and step-by-step instructions clearly written				
Building and Testing the Prototype o Prototype built according to the design requirements				
o Sufficient data gathered during the first testing. Data is analyzed if redesigning is necessary.				
Redesigning and Retesting: Redesigning and retesting done showing gathered data and analysis.				
Conclusion: Reveals evidence of learning				
II. Display				
o Neat, edited, and physically sound				
o Engineering method displayed, easy to follow, and self explanatory				
o Journal and display showed a close relationship				
o Creative Board Design				
III. Interview				
o Student shows a basic knowledge of field studied and able to elaborate				
o Student is able to explain how the engineering method was used				
o Student shows interest, enthusiasm, and a passion toward the project and could tell how it was personalized				
IV. Project Design				
o Creative, procedural approach with ingenious use of materials and equipment to solve the problem				
o Project shows in-depth thought and work to solve the problem				
o Results show a well, thought out, reasonable conclusion showing a useful connection to the world				

Score Ex. 5 Gd. 3-4 Fair 1-2

Sub scores				Total Score	/100

Science Fair Resources

Online Resources for Science Projects Ideas

- http://cusef.byu/edu
- www.sciencebuddies.org
- http://www.stevespanglerscience.com/content/experiment/science-fair-survival
- www.sciencebob.com

Online Resources for Environmental Science Projects

- http://www.isd77.k12.mn.us/resources/cf/SciProjIntro.html
- www.isd77.k12.mn.us/resources/cf/SciProjIntro.html
- www.detroit.lib.mi.us/is/science_fair.htm
- http://faculty.washington.edu/chudler/fair.html

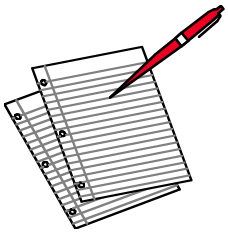
What an Engineering Design Science Fair Project Is and Is Not

A Science Fair Project using the Engineering Design is Not:

- Just building a product
- A report an engineering design
- A simulation or demonstration to show how something works
- A survey of what people think or feel about something
- A design that shows common knowledge that everyone knows
- A design that is copied from of a book or off the Internet
- Gathering statistics from a news source and reporting on the daily changes

A Science Fair Project using the Engineering Design is:

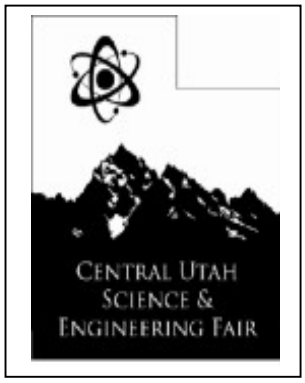
- Thinking of a problem to investigate and solving it by means of the building a prototype using the engineering design
- Planning a design to construct a prototype to solve the problem
- Follow through with constructing something that works
- Testing the prototype and analyzing data to gain knowledge
- Using the knowledge learned to make a connection to higher-level ideas and to understand those new ideas to see how to apply them to the real natural world



STUDENT SCIENCE FAIR PROJECT
SUGGESTED TIMELINE
USING THE ENGINERING DESIGN

Week	What is going to be accomplished?	Done
Week 1	Student becomes familiar with the engineering design. Student gets science fair journal ready. Student comes up with a topic and purpose for his/her science project design and writes it in the journal.	
Week 2	Student researches the topic by finding at least three sources and reading about them. He/she writes detailed paragraphs in the journal of specific details of what was learned.	
Week 3	Student writes his/her design requirements in the journal. Student begins the preliminary designs and narrows it down to the design desired. Student writes up a list of the materials needed.	
Week 4	Student writes up the final step-by-step procedure of the prototype in the journal. Student acquires the materials needed to build the prototype.	
Weeks 5-6 (or longer if needed)	Student builds the prototype according to the design requirements. Sets up a plan on how to test it. Student tests the prototype. He/she gathers data and writes the data in the journal. Student analyzes the data if it worked or not according to the design requirements.	
Week 7	If the prototype doesn't work according to the design requirements, then redesigning and retesting is necessary. Data is gathered and analyzed again. A conclusion is written up.	
Week 8	Student makes a creative display board using colors, decorative paper, different font size, pictures, and designs. It displays all parts of the engineering design (except the research). Student writes a brief explanation under each design step on the board. Student practices what he/she is going to say about each step for the interview.	

Directions for Filling out the 2012 Central Utah Science & Engineering Fair Registration Form For 5th and 6th Grades



All 5th and 6th grade students entering their respective school science fairs in Jordan District must fill out the 2012 Central Utah Science and Engineering Fair (CUSEF) Registration form for 5th and 6th grades to give to their teachers prior to beginning their science fair projects. There are certain rules that students must follow in doing a science fair project. If these rules are not followed the project can be disqualified at the district and regional levels. Filling out this form correctly and completely will guarantee admittance to all levels of competition.

After you have chosen a topic and prior to beginning your project, the next step is to fill out **completely** the Central Utah Science and Fair (CUSEF) Registration Form for 5th and 6th Grades. Your teacher will give you the CUSEF Registration Form when you receive this student packet. Below are the directions on how to fill out the CUSEF Registration Form. Completion of this form does not guarantee advancement to CUSEF but it will show that you have followed all the science fair rules for all competition levels.

Once you have filled it out, give it to your teacher for approval. If it is not complete he/she will give it back for you to complete. If you change your science fair research plan, then you must submit a new plan to your teacher. **If you are doing this project as a group (maximum of three students per project) you will only need to fill out one form.**

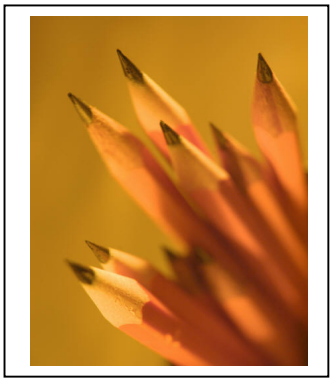
Directions To Filling Out the Four-Page CUSEF Registration Form

Page One—Student and Project Information

1. **Student Information**
   - This is to be filled out by you and anyone else who are doing this project with you. You can have up to three per project.
   - All the information needs to be filled in just in case you need to be contacted either by phone or mail.
2. **Project Information**
   - Fill out all information including teacher's name and his/her email. Your teacher's email will be the first and last name with a period between the first and last names ending with "@jordan.k12.ut.us".
   - Mark the box of which category your project is under. If you have problems knowing, look on pages "1a" and "1b" of the student packet, ask your teachers, or call Paul Nance at 801-244-6479 or email him at paul.nance@jordan.k12.ut.us**.**
   - Mark the boxes on the right if you are going to be experimenting on any of the things listed. If you are, you need to get some signatures before starting your experimentation found on page two of the registration form. If not, mark "none of these".
   - Answer the "yes" or "no" questions at the bottom.

Page Two—Science Fair Project Rules*

(This page is for the those projects that need Special Signatures)



Some projects require special signatures from professionals before you can begin them. These experiments may cause harm to humans and vertebrate animals without being screened. Laws have been set up to protect humans and animals from being hurt, disgraced, or diseased.

The following projects need special signatures from certain professional people listed below with the date they signed it.

- **If you are working with humans as subjects,** you must get **prior approval** from a science teacher, a school administrator, and one of the following: a psychologist (could be from your school), psychiatrist, medical doctor, physician's assistant, or registered nurse. Have each sign on the lines provided on the form. **Also, if any of your subjects are under 18, you need to get written permission from a parent of each child.**

- **If you are working with non-human vertebrate animals as subjects,** you must get **prior approval** from two science teachers and a veterinarian. Have each sign on the lines provided on the form. Proper animal care must be provided daily and there cannot be any pain or discomfort.

- **If you are working with controlled substances,** you must get **prior approval** from two science teachers and a school administrator. Have each sign on the lines provided on the form. All laws in handing the controlled substances must be followed. An adult must be present and supervise the experiment.

- **If you are working with hazardous substance or devices,** you must get **prior approval** from two science teachers and a school administrator. Have each sign on the lines provided on the form. Students must follow the laws in handling these substances or devices. An adult must be present and supervise the experiment.

- **If you are working with potentially hazardous biological agents (bacteria, mold, fungi, viruses, parasites, fresh human or animal tissues),** you must get **prior approval** from two science teachers and a biomedical scientist (usually found at a university or lab office). Have each sign on the lines provided on the form. Growing of unknown microorganisms must be grown in a sealed, unbreakable container such as a Petri dish and stayed sealed during the whole experiment. **The containers must be kept in a lab for observation and not in the home. If this experiment is done at home the project will be disqualified.**

If you have questions about these signatures ask your teacher or call Paul Nance at 801-244-6479 or email him at paul.nance@jordan.k12.ut.us.

***It is important to get these signatures before the experimentation begins. Otherwise, it may cause the project to be disqualified for further competition.**

Page Three—The Science Fair Project Research Plan

After you have chosen a topic, the next step is to write up the research plan for your teacher. There are a couple of reasons a research plan needs to be written.

- **There is pre-work that needs to be done before the actual experimentation. Knowing the steps you need to take to complete a science fair project will help you do a completed project.**
- **Your teacher can look at it and know that your project will be a safe and meaningful project.**

Filling out the Science Fair Project Research Plan includes the following:

1. Coming up with a question that can be answered by science experimentation.
2. Doing research on your topic.
3. Writing a hypothesis using the **"If….then"** phrase using background knowledge acquired during the research.
4. Writing a list of supplies needed for the experimentation.
5. Telling where your experiment will be conducted.
6. The name of your adult supervisor.
7. Writing up the actual procedure, in detail, how you plan to do your experiment.

- **Be sure to be complete when you write up your plan so you, your teacher, parents, supervisor and those who may need to sign it know exactly what you will be doing.**
- **If you change your science fair research plan, then you must submit a new plan to your teacher.**

Page Four—Display and Safety Rules and Student and Parent/Guardian Signatures

1. **Display and Safety Rules**
   - Be sure to read and know all the display and safety rules. They must be followed when displaying your project.
2. **Student and Parent Signatures**
   - All student and parent/guardian signature must be acquired before entering the school, district and CUSEF fairs. Please read the statement above the signature lines so you know what are signing. It is important that you know the rules and what is expected when you enter the different science fairs.
   - There is also a place for parent signatures if child and project information can be appropriately used for publicity purposed.
   - Your teacher also needs to sign and date that your project complies with the rules.
   - You don't need to have the "CUSEF Approval for Completion" at this time.