STUDENT RESEARCH AND EXPO PACKET – 2009

Introduction:
Below is a list of guidelines, explanations, and rules for conducting a student research project and how to enter your project in the Expo competition. There is a lot to know so make sure you are clear about the expectations. However, this document is only one resource and your sponsoring teacher is generally your first line of information. The Expo website http://www.rrps.net/Newrrhs/expo.htm is another useful resource and Mr. Keeney *(SC 116, 896-5773, or rkeeney@rrhs.rrps.k12.nm.us)* is the Science Review Committee Chair *(responsible for the review of all paperwork)* and can also answer questions that might arise.

Web Sites that will be Helpful:

http://www.rrps.net/Newrrhs/expo.htm **- Expo page – includes all forms necessary for RRPS Expo and other important information.**
http://www.unm.edu/~scifair/ – This is our regional Research Expo site.
http://infohost.nmt.edu/~science/fair/ – This is the New Mexico State Fair site.
http://www.sciserv.org/isef – Site for the Intel International Science and Engineering Fair and the official ISEF site.
http://www.pnm.com/sciencefair – Provides information from ideas to final presentation.
http://citationmachine.net/ – helps you properly format your bibliography *(free)*
http://www.easybib.com/#sourceList – another cite to help properly format your bibliography *(also free)*
http://gotoif.org/ – More info on research.

1. Most of you will do your own project, however you may have a partner or two *(up to three people may enter a team project)* if you so desire. Applications for team projects are no longer required.
2. Follow the sheets included in this packet that will not only guide you through each step of the scientific method, but will also help you pull things together at the end. Get an inexpensive three-ring binder for your Expo Project. Set up your binder with dividers and keep absolutely everything you do for this project in the notebook. The Table of Contents should be the first page in your notebook and should list the sections given below. Include the following sections:
    - Expo Project Information *(which is this handout)*
    - Literature Research *(minimum of 5 cited sources in standard format – APA, MLA, Chicago, etc.)*
    - Final Experimental Design *(rough draft(s) and final draft)*
    - ISEF forms *(see http://www.rrps.net/Newrrhs/expo.htm and sponsoring teacher for specifics)*
    - Raw Data
    - Data Analysis
    - Results
    - Discussion/implications
    - Tri-fold Text
    - Consultant Contact record if needed
3. There is a deadline checklist on the following page to keep track of what you have done.
4. You may change your project idea up until your project is accepted into the EXPO and this often happens as you become more involved with the details of your projects. However, preplanning and background research during your initial phases can help save a lot of changes later on.

Dates to Remember:
Last day for human subjects petition submission ……………………………Thursday September 18, 2008
Last day for vertebrate animal paperwork submission……………………Tuesday October 21, 2008
Last day for IRB (human subjects) paperwork submission………………..Thursday October 30, 2008
Last day for regular SRC paperwork submission …………………………Tuesday December 02, 2008
RRPS Research Expo……………………………………………………Thursday January 15, 2009
RRPS Expo Awards Ceremony…………………………………………….Monday January 19, 2009
Begin SRC Paperwork submissions……………………………………….**Anytime – Don't Wait!**

Assignment Due Dates: ***BOLD DUE DATES ARE SRC DEADLINES AND ARE FIXED. REMEMBER – THESE ARE HARD-DEADLINES!!! BEING ABSENT IS NOT AN EXCUSE. HAVE SOMEONE BRING IT IN FOR YOU, OR BETTER YET, PLAN AHEAD AND GET YOUR PAPERWORK IN EARLY!!!!***

Timeline for EXPO 2009

Due Date	Activities
Aug 14	Initial topic selection – three ideas (or only one if you have already decided on your topic)
Aug 21	Final topic selection – Typed.
Aug 28	Bibliography of at least five properly cited sources with annotations. An annotated bibliography is a list of your resources that includes a brief summary of the source and how it relates to your research. Typed.
Sep 04	• Problem statement and hypothesis. • Consultant contact information.
Sep 18	**LAST DAY for HUMAN SUBJECTS PETITIONS.**
Sep 18	Rough Draft of Final Experimental Design due. Typed.
Oct 2	Completed Final Experimental Design due. Typed.
Oct 13	• ISEF paperwork completed • All paperwork turned in to SRC/IRB (NOTE: Students may submit paperwork anytime before this date if they wish.)
Oct 21	**LAST DAY for initial VERTEBRATE ANIMAL project paperwork submissions. (Projects involving studies and experimentation with vertebrate animals.)**
A.S.A.P.	SRC/IRB approval. Submit and resubmit as necessary. Show approval to teacher as soon as you find out.
Oct 30	Data Check #1 if your project has been approved by the SRC. Some projects require ongoing data collection. Submit what you have collected or talk with your teacher for specific situations. If not yet approved by SRC/IRB, then: • No credit if paperwork is not yet submitted to SRC/IRB. • Excused if paperwork has been submitted to SRC/IRB at least once.
Oct 30	**LAST DAY for IRB project paperwork submissions (Projects involving human subjects – those requiring a form 4). It's HIGHLY recommended that you get your paperwork in at least 3 weeks before this deadline.**
Nov 06	Data Check #2 if your project has been approved by the SRC. If not yet approved by SRC/IRB, then: • No credit if paperwork has been submitted to SRC/IRB < 3X. • Excused if paperwork has been submitted to SRC/IRB 3X or more.
Nov 20	Data analysis due
Dec 02	**LAST DAY for SRC project paperwork submissions.** (Expo projects only) **This final deadline is established for extenuating circumstances** and should not be considered a normal submission schedule. For most projects, students should be submitting their paperwork in MID OCTOBER!
Jan 13	Tri-fold is due in class.
Jan 14	Project set-up in RRHS main gym. 7:00 pm to 9:00 pm.
Jan 15	*****RRPS Student Research Expo*****

<u>Topic Selection</u>: Trying to come up with a topic for research expo?
Try some of the methods below:

1. List 3 of your greatest interests. That is, topics that you think about when you are free to focus purely on <u>your</u> interests.
    a. How might you be able to develop a research topic from one of these interests?
2. List 3 problems in the world that you believe are significant and in need of solutions.
    a. What could you learn from studying the problem?
    b. How could research lead to a solution or solutions?
3. Think of your favorite hobby.
    a. Is there something that is annoying or doesn't work very well?
    b. Are there changes that could be made to make you hobby more efficient or enjoyable?
4. What line of work do you wish to pursue in the future?
    a. What problems exist in this field? What solutions could you pose?
    b. How might the job be made easier?
5. Read current events! Are there health, industry, environmental or social issues that would be timely, important, and fun to research?
6. Still not quite sure? Get out there and read in an "area" or broad topic in which you are interested. Here you may come up with an idea as you learn background information. The more informed you are about a topic the more easily you can raise a question. Make certain to keep records of where you find information so you can come back to it.

Once you choose your topic, use these questions to decide if it is a good choice:

1. Does the topic sound interesting to you?
2. Can you make some sort of measurement and what will that be? *(dependent variable)*
3. Can you change something in the project that could impact your measurement and what will you change? *(independent variable)*
4. Will you be able to control all other items so they do not impact your results?
5. Will you be able to find 5 literature research sources that will help you write a literature research section that helps answer the problem statement?
6. Will you be able to collect enough data?
7. Do you have the material that is needed for this experiment?
8. Do you need special equipment?
9. Can the project be completed in the allowed time?
10. Cost of completing the project; is it too expensive?
11. Are there requirements for the use of any vertebrate *(frogs, mice, goldfish, humans, etc.)*?
12. Are you willing to get signed consent for human subjects projects. The approval process is very involved.
13. Are you willing to go beyond basic statistics for surveys? More statistics must be done on surveys.

PROPOSED TOPIC: ____
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Literature Resources:

When you do literature research, you want to find articles and books that can teach you something about the aspects of your project. Don't reinvent the wheel, but build upon it. Learn about the topic so that you can make a hypothesis or engineering goal based on intelligent information. Your conclusion or final product will have to be related to what you learn about the variables now and how they turn out in your project. Therefore, literature research is the foundation of a good hypothesis, a viable project, and a meaningful conclusion.

NO COMPLAINING ABOUT HOW HARD IT IS TO FIND SOURCES FOR YOUR TOPIC. Don't wait until the last minute. Take advantage of Infotrac, an online source of articles that our school subscribes to. Visit other libraries if necessary. This step is not hard, but it requires you to plan and be persistent. To access Infotrac enter the following URL on the Internet. The password is "cactus".
http://infotrac.galegroup.com/itweb/nm_s_riorhs

YOU MUST HAVE AT LEAST 5 SOURCES: 2 journal or book sources, 1 peer-review journal source, and 2 sources of your choosing (internet, personal interview, etc). Each source must be included in your bibliography with a one-paragraph summary to be turned in along with the article on the due date stated on your Grading Sheet/Checklist and Deadlines. Paperwork WILL BE rejected by the SRC if these sources are not properly cited or there are fewer than five.

A WORD OF CAUTION: Websites are commonly used references at the high school level and can be very useful and convenient. However, understand that anyone can post information on the Internet without having it reviewed for accuracy. If you find useful Internet information don't rely solely on that source, but be sure to find other resources that back it up.

Bibliographic Format:

Works Cited: Every source that you used should be cited whether you quote it directly or not. This includes *(but is not limited to)* professional journals, newspapers, magazines, encyclopedias, textbooks, web pages, personal interviews, etc. The citations are generally put in order by the author's last name. Use a copy of Writer's Inc., or visit http://citationmachine.net/, http://www.easybib.com/#sourceList, or other online source to help properly format your bibliography.

Note #1: It is often difficult to find all the necessary information when properly citing a webpage. Just be sure to include all information that you can and don't worry about what you cannot find.

Note #2: When line length forces you to break a Web address, always break it after a slash mark. However, it's also fine to have an early line break. *(This is what auto-formatting usually does for you.)*

Note #3: Journals are usually issued no more than four times a year. Number 31 refers to the volume. The issue number is not needed if the page numbers in a volume continue from one issue to the next. If the page numbers start over with each issue, then put a period between the volume number and the issue number: 31.2.

Note #4: When you use a library to access a subscription service, include the name of the database if known *(underlined)*, the service, and the library, all before the date of access. Then give the Internet address for the home page of the service, if you know it.

<u>Problem Statement:</u> *(The following information about Problem Statements and variables is not applicable to engineering projects. See the next page for appropriate guidance if you're planning on doing an engineering project.)*

The next step is to turn your topic into a problem statement for the project. The problem statement is a sentence or question that identifies the **independent variable** and the **dependent variable**.

Independent variable: the variable or factor that you <u>manipulate or change</u>
Dependent variable: the effect that you <u>measure or collect</u> as a result of changing the independent variable

<u>Example</u>: "How does the moisture content of Bosque soil affect its water absorption rate during a rainstorm?"
<u>Independent variable</u>: "amount of moisture in the soil" *<u>Dependent variable</u>: "rate water is absorbed"*

Notice in the example that both the independent and dependent variables are *measurable*, so don't rely on just that to determine which the dependent variable is. Now, think about your topic and brainstorm a few possible independent and dependent variables that you could use. List them below. However, when designing your experiment, you want to vary only one independent variable at a time, otherwise you cannot be sure what is causing the changes *(if any)* in you dependent variable(s).

<u>Independent Variables</u>	**<u>Dependent Variables</u>**
______________________	______________________
______________________	______________________
______________________	______________________

Write your Problem Statement: (*format* – Independent variable affects/influences Dependent variable)

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<u>Hypothesis</u>: *(The following information about Hypotheses is not applicable to engineering projects. See the next page for appropriate guidance if you're planning on doing an engineering project.)*

After learning about the independent and dependent variables, you must make an educated guess about how the experiment will turn out. The hypothesis is one sentence *(normally)* that states what you think the answer to the problem statement will be based on what you learned in your literature research. IT IS CRITICAL TO DO PROPER PRELIMINARY RESEARCH! REMEMBER, A HYPOTHESIS IS AN **<u>EDUCATED</u>** GUESS. At the elementary and middle school levels, the sentence is often an "if, then, because" statement, although it does not have to be, and often isn't in higher-level research. In fact, it is appropriate to simply state you hypothesis in a declarative form. However the format is your choice, but if your experimental design will not test the "because" portion, and it is not otherwise established knowledge, then you should leave it out.

<u>Example</u>: "Bosque soil will absorb moisture at an increasing rate proportional to the amount of water it holds until it reaches 80% of its saturation point."

Write Your Hypothesis: ____

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<u>Engineering Projects Format</u>: If you're planning on doing an engineering project, follow these guidelines for the format of your problem statement and hypothesis. The "science" aspect of your project is actually encompassed in the "design" portion and not the "construction" portion. In other words, if you want to get plans to build something *(a seismograph for example)* off the Internet or elsewhere and then build it, your proposal will be rejected by the SRC. However, it is valid to build something that is predesigned and use it to collect data, or take a preexisting item and then modify it through test and evaluation. If you construct something in order to collect data your project then is no longer an engineering one, but a standard "science" investigation. As an additional note, computer programming projects, where the objective is to write a program to accomplish a given task, are considered engineering projects.

<u>Problem Statement</u>: In engineering projects, you generally do not have independent and dependent variables. Rather you have a task to achieve, or an obstacle to overcome. Therefore, your problem statement should address this. Below are several examples of valid problem statements.

<u>Example #1</u>: Wheelchair lifts for vehicles are very expensive and often prohibitive in cost for lower income people and families. Less expensive, yet reliable models need to be made available.

<u>Example #2</u>: Solar panels are more effective when they face the sun at a perpendicular angle. The efficiency of commercially available panels can be increased by building low-power-usage tracking platforms.

<u>Example #3</u>: The software my company uses can only track inventory by part number or official nomenclature. Their customers often have to wait too long while we have to cross-reference parts by common name.

<u>Engineering Goal:</u> This takes the place of the hypothesis in standard "science" investigations. It is simply a statement of what you plan to design and build. However, make sure to include objective aspects on its design so you can determine if you've achieved your goal(s) or not. Below are several examples of valid engineering goals that correspond to the problem statements above.

<u>Example #1</u>: Design and build a wheelchair lift that will fit in the bed of any pickup. The total materials cost will be under $200, available locally, and constructible by tools available at our local home improvement shop.

<u>Example #2</u>: Design and build a computer controlled tracking mount for a 2 by 6 foot solar panel that will keep the panel perpendicular to the sun (even on cloudy days) to within 3 degrees and use only 5% or less of the energy produced by the panel.

<u>Example #3</u>: Write, debug, and test a subroutine program to add to my company's inventory program that will enable employees to find the inventory status of parts by common name with at least 90% accuracy.

Note that in all three engineering goal examples, specific criteria were set so that the researcher could determine whether or not the engineering goal was actually meet by the end of the project.

Choosing a Consultant: This can be someone local or can be an online collaboration with someone. Below, a script is provided for Initial Contact with a Consultant along with a list of do's and don'ts and some specific etiquette! A record of all communication with the consultant is kept in your notebook. Notes must be made on phone calls. A Consultant Information Sheet is filled out when your consultant is chosen and accepts. Here are some websites to find online consultants or just ask some questions: http://experts.com and http://www.askanexpert.com/

Etiquette First: *(Taken from http://www.askanexpert.com/)*
Be nice. It's what your momma told you to do, and it's good advice. All of our experts are graciously volunteering their services, so don't be too demanding. "Please" and "Thank you" will help you get more timely and complete responses.
Be patient. Response time varies from expert to expert. One week is pretty typical. If you need an answer for a report or school assignment, try to plan ahead and ask your question early. It's not realistic to expect an immediate answer.
Search first, ask later. Many experts have an FAQ (frequently asked questions) list on their page. Search these before you ask your question because it might have already been asked (and answered). Also, the content on the expert's Web site might help answer your question.
Get real! The experts will not write a five-page essay on the behavioral characteristics of an angry wombat. Sorry, but you still have to do your own homework. **The experts are, however, more than happy to answer any legitimate and sincere questions that might help you with a project or just satisfy your curiosity.**

Possible Script for Initial Consultant Contact:

Hello, my name is ________________________________ and I am a student at (school) ________________ ______in (city, state) __________________________________. I have read (name or number of articles) __ ______ on (topic) ______________________________________. I am interested in (topic) _____________ ____________ and under the guidance of my science/math teacher I am planning to investigate (statement of question) ________________________________. I have a few questions that I need to have answered before I begin my experiment. I realize you are very busy, but I'm hoping you could take a few minutes to answer my questions.
(Wait for a response from scientist. If he/she says yes, then ask questions. Be sure to write each question on a Communications form or leave ample room between questions to write the scientists answers. After your questions have been answered continue with the script.)

Thank you for answering my questions. You have really helped me. I know you have a busy schedule and I really appreciate your help. If I have any other questions, could I call, write or e-mail you? Would anyone at (name of lab, school, or organization)_____________________________ be available to help me? (If the response is yes, then say, "Thank you very much. How would you prefer I contact you?") (If the response is no, then say, "thank you very much for your time."
Please provide the following information regarding your consultant to your teacher.
Your name __________________________
Your Topic ____
Name, address, and telephone number of your consultant:
Name: ____________________________________
Address: ____________________________________
____
Phone: ____________________________________
E-Mail: ____________________________________
Best time to contact, if known: ____

Consultant Contact Log: To be continued on another sheet of paper using this format

Date *Time* *Person Contacted* *Topics Discussed*

ISEF Format: ***Make sure that every section is completely filled out or it will be rejected!***

The ISEF forms need to be filled out very carefully and completely. Use black ink or type them directly from the internet (http://www.rrps.net/Newrrhs/expo.htm)

The following 7 forms are required by all students: *(current year's versions)*

- RRPS Registration form
- Checklist for Adult Sponsor / Safety Assessment Form (1)
- Research Plan (1A)
- Research Plan Attachment *(Attach your Final Experimental Design to this form – this must be typed)*
- Approval Form (1B) *(one for each team member)*
- Ethics Contract *(one for each team member)*
- Media Consent form *(one for each team member)*

If you are involving humans in your research *(even if it is only in a survey)* then you must also:

- Submit a petition to SRC. *(see teacher or http://www.rrps.net/Newrrhs/expo.htm)*
- Include a Human Subjects and Informed Consent Form (4) if your petition is accepted.

If you are working with anything that could be considered dangerous *(even a power tools are considered dangerous)* then you should also have: Risk Assessment Form (3)

If you are working with any vertebrate animals *(any animal with a backbone, including all fish, reptiles, amphibians, birds, or mammals)* then you'll also need a Form (5A), Form (3), and perhaps a Form (5B), Form (1C) and Form (2). Invertebrate studies do not require any of the above forms, but there will need to be scientific justification in your experimental design if any of your procedures will harm the invertebrates.

Other forms that you might need include:

- Registered Research Institutional / Industrial Setting Form (1C)
- Qualified Scientist Form (2)
- Potential Hazardous Biological Agents Form (6A)
- Human and Non-Human Vertebrate Animal Tissue Form (6B)
- Continuation Projects Form (7)

<u>Final Experimental Design</u>

Put this in the “Final Experimental Design” section of the notebook. The final experimental design will be the procedure that you will turn into the SRC/IRB for approval along with all the necessary forms and ISEF paperwork. Your <u>final experimental design must be typed</u> with the bold words listed below in the correct order. **<u>Attached it to the back of the Research Plan Attachment form!</u>**

1) **Title**: Be creative but clear, not cryptic. A knowledgeable person should be able to get the gist of the project from the title.
2) **Purpose/Question**: What do you hope to find out or achieve by doing your project. What question(s) do you wish to answer?
3) **Hypothesis or Engineering Goal**: What do you think (based on researched information) will be the outcome of your project? Leave out the phrase, “I believe…” That’s inferred. If you didn’t believe it, it wouldn’t be your hypothesis.
4) **Materials and Equipment**: Include <u>all</u> materials and equipment, specifying quantities, concentrations, voltage levels, equipment specifics (make and model), and use technical names (not just common household terms).
5) **Independent variable**: Remember – the independent variable is the one that you are manipulating, or at least allowing to change to see its effect on the dependent variable. This section is not applicable for engineering projects.
6) **Dependent variable**: This is what is being affected by the independent variable. It is what you measure to obtain the results of your experiment. This section is not applicable for engineering projects.
7) **Control**: A control is a trial (or many) taken when the independent variable is missing, held constant, or at its base or normal level. It is a reference used to gauge how the dependent variable has changed from what is normal or ordinary. A control is not always possible, but very important if it is possible. This section is not applicable for engineering projects.
8) **Number of Samples/Trials**: A given trial or sample should have only ONE independent and ONE dependent variable. If it has more of either, then it is usually not a viable experiment. A given project may be looking at multiple independent and/or dependent variables, but the relationships among them must be determined by one-on-one trials. If you have more than one of either independent or dependent variables, then you must incorporate multiple trials to test the possible combinations. If you are doing an engineering project, then elaborate on how you plan to test your design to see if you’ve met your engineering goal criteria.
9) **Constants**: Many factors can affect the dependent variable besides the independent variable that you are testing. Ideally, all of these others need to be held constant, **<u>and therefore these are your constants</u>**! In order for the results to strongly verify that only your independent variable is affecting the outcome, all of these need to be listed and somehow accounted for in your experimental design. However, it is not always possible to keep these constant, and in those situations, more trials are needed to statistically nullify the other factors’ effects. This section is not applicable for engineering projects.
10) **Procedure**: Use a <u>numbered or bullet</u> format throughout (NOT paragraph form!) to list the steps you plan to take when doing your project. *<u>This section should be so detailed that another person, knowledgeable in the subject, should be able to do the research following your directions</u>*. However, leave out obvious statements like, “Gather all the materials.” <u>For engineering projects, at least one detailed scale drawing of the project must be included</u>.
11) **Data Analysis**: How do you plan to analyze (process) your data in an objective manner in order to support or refute your hypothesis? It is not sufficient to say that you are going to look at the results and come up with a conclusion. This is subjective. An independent person should be able to review your results and arrive at the same conclusion as you by the analysis method(s) you establish in this section. Inferential statistics are often preferable, but not required. You may also use criteria that you determine, or are standard in your field of research. For example you may state, “The hypothesis will be supported if there is

at least a 15% mean increase in the number of the sample receiving the treatment as compared to the control group." If you are doing an engineering project, then you need to include evidence that you met *(or didn't meet)* the criteria you established in your engineering goal.

12) **Proposed Charts, Tables, Graphs, Drawings and Diagrams**: What will you use to collect and display data. Include types, titles, and labels of axes. Engineering proposals must include at least one scale drawing or CAD printout of the project.
13) **Safety and Confidentiality Information**: Don't leave this section blank. You need to include **all** precautions that you will take to ensure that no person, animal, or property will be accidentally or needlessly harmed or damaged as a result of your experimentation. Include proper handling, safeguarding and disposal information of hazardous materials in this section. Protection of personal and/or identifying information also falls into this category. Improperly or incompletely filling out this section is a major reason that paperwork is rejected by the SRC. If there are truly no safety concerns, *(this usually only occurs in purely mathematical or otherwise abstract projects)* then state so in this section.
14) **Key Bibliographic References**: On which your research and hypothesis are based *(At least 5)* – properly formatted. *(MLA, APA, Chicago, or other standard format)*
15) **Abstract**: ****This won't be included until the project is finished, and therefore, cannot be submitted with the ISEF paperwork!*** However, an abstract IS required for Expo competition.*
16) **Location of your research work**: List all of them. The school's info is always needed, even if none of the research will be conducted there.
17) **Contact person at that site**: For each site, list name and phone number. It is fine to list yourself if it is applicable.
18) **Telephone number**: Your own contact number.
19) **E-mail address**: Your own email address.
20) **Additional notes**: Whatever else you might think important.
21) **Form 4 Information:** This is applicable only if you are doing a project that requires a Form 4 – Informed consent form. These are also known as "Human Subjects" projects.

What Needs to be on Your Tri-fold

Title: - Same as the one in your Final Experimental Design

Abstract: - An abstract is a complete summary of your project, including results. A template for a properly-written abstract is included on the following page. This should be placed first (after your title).

Introduction:

- What is the **purpose** of the study? What is your original question or goal? Why was the study done?
- What information did you already know about this topic? For example, what have you observed? What have others already discovered that is pertinent to this investigation?
- This section is to be written in paragraph form. Use complete sentences. The introduction should let the reader know what the investigation is about, even if they knew nothing of your study beforehand.
- In describing the work or conclusions of others, you must give proper credit by using author-date reference citations [e.g. (Marieb, 1997)].

Hypothesis or Engineering Goal: - Same as the one in your Final Experimental Design.

Procedure: - Include the step-by-step procedure, the independent and dependent variables, controls, constants, and number of trial. This should be the same procedure as the one in your Final Experimental Design.

Summarized Data: - You may summarize your raw data in table, chart, or graph form.

- Graph or otherwise summarize the data as appropriate. Raw data is normally kept in your notebook.
- High values, low values, averages, trends, statistical analyses, etc. are important to display.
- Compare each of the data tables and graphs of the control and experimental groups.

Data Analysis: - Describe and illustrate the methods and calculations you used to analyze your data so that you were able to either support or refute your hypothesis.

Results: - Summarize what you discovered by doing your project. Don't forget the obvious: "Was you hypothesis supported or refuted? Did you meet your engineering goal(s)" Remember, you do not have to find your hypothesis correct or meet your engineering goal in order for it to be a good project. A lot of important scientific information is gained by refuting a hypothesis and good stuff is made outside of engineering parameters.

Conclusion:

- Restate the purpose or original question.
- Restate the hypothesis or engineering goal.
- Use the analysis to explain if the hypothesis was or was not supported by data or the engineering goal was met.
- If the hypothesis was not supported by the experiment or engineering goal not met, explain what you think happened. If appropriate, state an alternative hypothesis or engineering goal.
- Discuss other factors that may have affected you results *(e.g. variables that you could not or did not control).*
- Discuss errors you made in the investigation or design.
- Discuss interesting questions, which your results lead you to ask. What is the importance of this project? What impact could your results have? How might this study be expanded? What spin-off experiments or designs could you do from this one? What, if any, implications might this have in the "real world"? This section is to be written in paragraph form. All of the sentences are to be complete. The conclusion should let the reader know what the investigation is about, what the hypothesis or engineering goal is, and whether or not the hypothesis is supported by the data or the engineering goal met, even if they knew nothing of your study beforehand.

Bibliography: - This includes the reference citations only *(not the summary paragraphs)*, properly formatted.

<u>Template for a well written Abstract</u>

- Write a sentence making broad statement about the topic of research.
- Write the next sentence or two focusing more narrowly on the particular intent of the research.
- Write several sentences indicating the problem to be solved and the hypothesis that was posed.
- Write a very brief statement to describe the methodology employed.
- Write several concise statements indicating which variables were explored and compared, and if the data obtained supported the hypothesis. These sentences summarize the results and discussion sections of the research paper.
- Write a sentence that gives the conclusion(s) of the research work and a statement of the direction for future research.
- Count the number of words for the sentences you just wrote. If you need to, edit your sentences to bring your abstract within the required 50-250 word count.
- Put all previous sentences in paragraph form.
- Traditionally, use third person, passive voice. For example, write, "The results demonstrated a strong connection between…" instead of, "I found a strong connection between…" However, it is becoming more acceptable to write an abstract it first person. None-the-less, be aware that the tone of the abstract must emphasize the research and not the researcher. Also, understand that judges have their preferences, and you may find ones with opinions either way.

<u>General Information for Students in the Rio Rancho Student Research Expo</u>

Project Set-up: You must set up their projects during the designated time (the night before the expo from 7-9 pm in the gym) or must apply for a special "late set-up" sticker. After receiving your registration packet, find your booth, set up your project, and then find a person wearing a bright orange vest. They are the Display and Safety inspectors and have to inspect and approve your display before you can leave. THERE ARE MANY RESTRICTIONS TO WHAT CAN BE DISPLAYED, SO SEE THE SECTION TITLED, "DISPLAY AND SAFETY REGULATIONS" IN THE NEXT SECTION BELOW.

Entrance Into the Fair: Students are required to wear the nametag that will be given out when projects are set up. WITHOUT THE NAMETAG, YOU WILL NOT BE ALLOWED INTO THE EXPO!

What should I Wear to the Expo: Students are required to wear Rio Rancho Public Schools dress code unless they are wearing business attire that includes business slacks/skirts and business shirts. Sleeveless shirts will not be allowed. Formal wear such as prom dresses and tuxedos are NOT appropriate for the Expo.

Can I have a chair: Students may bring one small portable or fold-up chair (not a school chair) to have at their booth at the Expo. Chairs must not block the aisles and must be removed at the time projects are taken down.

What can I Bring to the Expo: Bring a book to read or homework to do while you are waiting for your next judge. Portable radios, CD players, cell phones, video games, etc, ARE NOT ALLOWED TO BE USED AT THE EXPO. Being at the Expo carries the same expectations as being in class.

Behavior at the Expo: When you are in the Expo you are a representative of your family, school, and community. You are also competing for cash prizes. Of course you will want your behavior to reflect these facts. Inappropriate behavior at the Expo is not acceptable. The rules in your school agenda still apply at the fair. If you misbehave, you can be ejected from the Expo and sent back to class, affecting your chances at prizes and your grade in class.

Judging: The two following sections are "Possible Questions Judges Might Ask" and "Judging Rubric". The questions have been provided to the judges have been given as a possibility to ask you. The judging rubric is what judges will use to score you. These items should help you prepare yourself for judging. During judging you must be at your booth at all times other than their break time. The judges will be given a schedule of when your break time is. If you are not at your booth when you are supposed to be, the judges are permitted to give you a score of zero! Your teachers will be informed if you got a zero because you weren't at your booth and this will affect your grade in class.

Display and Safety Regulations

Listed below are the general guidelines for what may and may not be displayed at your booth. You may be surprised at some of the restrictions, but remember, this is a high school research fair, and the judges are more interested in your ability to discuss the aspects of your project, rather than for you to reproduce it through demonstration. One consideration if you want to display something that is restricted, is to photograph or film the items or process, although see the guidelines for photos and visual depictions in the right-hand column below.

Not Allowed at Project or in Booths	**Allowed but With Restrictions**
1. Any living organisms, including animals, plants, microorganisms, fungi, mold, algae, etc. 2. Taxidermy specimens or parts 3. Preserved vertebrate or invertebrate animals or parts 4. Human or animal food 5. Human/animal parts or body fluids 6. Plant materials (living, dead, or preserved) which are in their raw, unprocessed, or non-manufactured state (Exception: manufactured construction materials, such as lumber, used in building the project) 7. Laboratory and household chemicals INCLUDING WATER. (Exceptions: water integral to an ENCLOSED apparatus) 8. Poisons, drugs, controlled substances, hazardous substances or devices, makeup, or anything that can make a mess 9. Dry ice or other sublimating solids 10. Sharp items or edges 11. Flames or highly flammable materials. Paper is not considered highly flammable. 12. Batteries with open-top cells 13. Awards, medals, business cards, flags, endorsements. 14. Photographs or other visual presentations depicting vertebrate animals in surgical techniques, dissections, necropsies, or other lab procedures 15. Active Internet or e-mail connections 16. Glass or glass objects unless deemed by the Display and Safety Committee to be an integral and necessary part of the project (for example, a monitor screen) 17. Any apparatus deemed unsafe by the Scientific Review Committee or the Display and Safety Committee (for example, large vacuum tubes or dangerous ray-generating devices, empty tanks that previously contained combustible liquids or gases, pressurized tanks, etc.) 18. The student's name written anywhere on the front of the display board or front cover of the research notebook, or otherwise visible by the judges. It is okay to have the name written on the back of the board and on the SRC paperwork included in the notebook.	1. Soil or waste samples if permanently encased in a slab or acrylic 2. Photographs and/or visual depictions if: a. The are not deemed offensive or inappropriate by the Display and Safety Committee b. There are credit lines of their origins "Photograph take by… or Image take from…" are attached. If all photographs being displayed were taken by the student or are from the same source, one credit line prominently displayed is sufficient. c. They are from the Internet, magazines, newspapers, journals, etc, and credit lines are attached d. They are photos of the student e. They are photographs of human subjects AND signed consent forms (Humans Subjects Form 4) are included in the student's research notebook. f. They are photographs of those otherwise involved in the project and a signed consent form giving specific permission for the photos to be displayed in the project is included in the student's research notebook.. g. Any identifying features or other personal information (face, corporate or institutional logo, license plate number, street address, etc.) are blackened out or otherwise concealed. 3. Any apparatus with unshielded belts, pulleys, chains, or moving parts with tension or pinch points if for display only and not operated 4. Class II lasers (<1mW) if a. Operated only by the student b. Labeled with a sign reading "Laser Radiation, Do Not Look into Beam" c. Enclosed in a protective housing that prevents physical and visual access to beam d. Disconnected when not operating 5. Class III and IV lasers if for display only, and not connected to power supply or operated 6. Any apparatus producing temperatures that will cause physical burns if adequately insulated

Electrical Regulations	Maximum Size of Project
1. Electrical power supplied to projects and, therefore, the maximum allowed for projects, is 120 Volt, A.C., single phase, 60 cycle. Maximum circuit amperage/wattage available is determined by the electrical circuit capacities of the exhibit hall, but are generally the same as a single household outlet. 2. All electrical work must conform to the National Electrical Code or exhibit hall regulations. 3. All electrical connectors, wiring, switches, extension cords, fuses, etc. must be UL-listed and must be appropriate for the lead and equipment. Connections must be soldered or made with UL-listed connectors. Wiring, switches, and metal parts must have adequate insulation and over-current safety devices (such as fuses or breakers). Exposed electrical equipment or metal that possibly may be energized must be shielded with a non-conducting material or with a grounded metal box to prevent accidental contact. 4. Wiring which is not part of a commercially available UL-listed appliance or piece of equipment must have a clearly visible fuse or circuit breaker on the supply side of the power source and prior to any project equipment 5. There must be an accessible, clearly visible on/off switch.	30 inches (76 centimeters) deep 48 inches (122 centimeters) wide 108 inches (274 centimeters) high (from floor to tope of project) The tables will not exceed a height of 36 inches (91 centimeters). Maximum project sizes include all project materials and supports. If a table is used, it becomes part of the project and must not itself exceed the allowed dimensions nor may the table plus any part of the project exceed the allowed dimensions. Any project with a component that will be demonstrated by the student must be demonstrated only within the confines of the student's booth.

Possible Questions Judges Might Ask

- How did you come up with the idea for this project?
- What did you learn from your background search?
- How long did it take you to build the apparatus?
- How did you build the apparatus?
- How much time *(days)* did it take to run the experiments *(grow the plants, collect each data point, etc.)*?
- How many times did you run the experiment with each configuration?
- How many experiment runs does each data point on the chart represent?
- Did you take all data *(run the experiment)* under the same conditions, *(e.g., at the same temperature, time of day, lighting conditions?)*
- How does your apparatus /equipment/instrument work?
- What do you mean by the terminology or jargon used by the student?
- Do you think there is an application in industry for this knowledge/technique?
- Were there any books that helped you do your analysis/build your apparatus?
- When did you start this project? or, How much of the work did you do this year? *Some students bring last year's winning project back, with only a few enhancements. (Not the best strategy.)*
- What is the next experiment to do in continuing this study?
- Are there any areas that we have not covered which you feel are important?
- Do you have any questions for me?

Ethics Concerns

Honesty in research and academics in general, is a very serious issue. Imagine if a drug company misrepresented the effectiveness of their newest drug, or an automobile company lied about the safety of its newest car. Although student research probably will not now impact society in the same way, the lessons learned and standards set are important. As a result, the consequences of such actions are significant. Students who cheat on any part of their research will receive a zero on the entire project, be called into their academy principal’s office and receive appropriate school consequences for cheating or plagiarism (usually Friday School Detention and annotation in the student’s school records), and will be required to return any awards, certificates, and other recognition they may have received. Unfortunately, this has happened in the past, and is a very embarrassing situation for all involved. Cheating is defined as any form of intentional misrepresentation of the project. This may range from changing a few of the results in order to obtain the desired results, to faking the entire project, cutting and pasting a project design from the Internet or other source, or not obtaining legitimate signatures on the human subjects informed consent forms. It is a far better decision to turn in incomplete work or less-than-desirable results than to cheat.

Judging Rubric:

CATEGORY	10 – Excellent	8 – Very good	6 – Good	4 - Fair	2 – Poor
Creativity Ability	1) Does the project show creative ability and originality in the questions asked? the approach to solving the problem? the analysis of the data? the interpretation of the data? the use of equipment? the construction or design of new equipment? 2) Creative research should support an investigation and help answer a question in an original way. 3) A creative contribution promotes an efficient and reliable method for solving a problem. When evaluating projects, it is important to distinguish between gadgeteering and ingenuity.				
Scientific Thought	1) Is the problem stated clearly and unambiguously? 2) Was the problem sufficiently limited to allow plausible attack? Good scientists can identify important problems capable of solutions. 3) Was there a procedural plan for obtaining a solution? 4) Are the variables clearly recognized and defined? 5) If controls were necessary, did the student recognize their need and were they correctly used? 6) Are there adequate data to support the conclusions? 7) Does the student or team recognize the data's limitations? 8) Does the student/team understand the project's ties to related research? 9) Does the student/team have an idea of what further research is warranted? 10) Scientific literature cited or only popular literature (i.e., local newspapers, Reader's Digest)?				
OR **Engineering Goals**	1) Does the project have a clear objective? 2) Is the objective relevant to the potential user's needs? 3) Is the solution workable? Acceptable to the potential user? Economically feasible? 4) Could the solution be utilized successfully in design or construction of an end product? 5) Is the solution a significant improvement over previous alternatives? 6) Has the solution been tested for performance under the conditions of use? 7) Does the student/team understand the solution's limitations? 8) Does the student/team have an idea of future solutions?				
CATEGORY	**5 – Excellent**	**4 – Very good**	**3 – Good**	**2 - Fair**	**1 – Poor**
Thorough-ness	1) Was the purpose carried out to completion within the scope of the original intent? 2) How completely was the problem covered? How complete are the project notes? 3) Are the conclusions based on a single experiment or replication? 4) Is the student/team aware of other theories and scientific literature in the studied field? 5) How much time did the student or team spend on the project?				
Skill	1) Does the student/team show the required laboratory, and observational skills to obtain data? 2) Does the student/team show the required computational and design skill to obtain data? 3) Was the project completed under adult supervision, or did the student/team work largely alone? 4) If the equipment could have been built independently was it built? Was it obtained on loan?				
Clarity	1) How clearly does the student discuss his/her project and explain the purpose, procedure, and conclusions? Watch out for memorized speeches that reflect little understanding of principles. 2) Was the presentation done in a forthright manner, without tricks or gadgets? 3) Does the written material reflect the student or team's understanding of the research? 4) Are the important phases of the project presented in an orderly manner? Are data and results clear? 5) How well does the project display explain the project?				
Teamwork (only if applicable)	1) Are the tasks and contributions of each team member clearly outlined? 2) Was each team member fully involved with the project, and is each member familiar with all aspects? 3) Does the final work reflect the coordinated efforts of all team members?				

<u>Sample Teacher Grading Guideline</u>:

Category	Points	Description
<u>Scientific Process</u>	**50**	Project was very **feasible**. It **tested** exactly what was **claimed**. The question and investigation showed **ingenuity**, **scientific rigor**, **thought** and **understanding**. There was a **control** if possible. **All of the factors** that affected the process were acknowledged and accommodated for. A **statistically significant sample** of data was taken.
	25	Project was somewhat feasible. It tested some of what was claimed. The investigation showed some ingenuity, scientific rigor, thought and understanding. The control, if applicable, was poor. Some of the factors that affect the process were acknowledged and accommodated for. More samples of data could have given better results.
	0	Project is not feasible. It does not test what is claimed. The investigation showed little or no imagination, scientific rigor, thought and understanding. There was no control when one was needed. Few or none of the factors that affected the process were acknowledged and accommodated for. Little, if any samples of data were taken.
<u>Level of Investigation and Effort</u>	**30**	Student clearly **dedicated** himself or herself to investigating the question posed. There was **obvious effort** extended over the course of the assignment. Student researched numerous possible avenues, **discovered new information**, **collaborated** with knowledgeable sources, and did extensive **background research** on the topic.
	15	Student spent the necessary time required but no more. There was average effort extended over the course of the assignment. Student researched some avenues, discovered little new information, collaborated with a few convenient sources, and did little background research on the topic.
	0	Student spent inadequate time. There was minimal effort extended. Student did not researched different avenues, discovered no new information, collaborated with no external sources, and did insufficient background research on the topic. Everything appeared last minute.
<u>Organization</u>	**15**	Project followed a **logical flow** that drew the observer along in an enticing way. There were no abrupt changes in thought or direction. Proper order (outlined in report requirements) was maintained. **All of the necessary constituents were present.**
	8	Project's flow was choppy and disjointed, but could be followed. There were some abrupt changes in thought or direction. Proper order was partially maintained. Some of the necessary constituents were present.
	0	Project's flow was very disjointed, and could not be followed, or only followed with great effort. Thoughts were scattered or incoherent. Proper order was not maintained to any degree. None of the necessary constituents were present.
<u>Appearance</u>	**5**	Overall appearance **captured the interest** of the observer. There were ample **visual**, and other sensory effects. The presentation was **neat**, **well defined**, and its appearance **complimented the project's theme and purpose**.
	3	The appearance partially captured the interest of the observer. There were a few visual effects. The presentation was neither sloppy nor neat, only somewhat defined, and its appearance vaguely complimented the project's theme and purpose.
	0	The project was slapped together in a last minute, ditch-effort to get in something, because it was put off until a ridiculous hour of the night, the day before it was due.