The Student Scientist Workbook

2016 Teacher Edition
Ashley Budd
Tara Wion

A complete guide to developing an award-winning science fair project. Includes detailed information, helpful worksheets, and clear instructions for each step of the scientific process.
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* indicate assignments

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# PORTFOLIO RUBRIC

**Directions:** The bold print helps identify major criteria that should be present in the portfolio. You will complete this evaluation and give yourself a final grade. Be honest with yourself and your efforts. Select each category as exhibiting “Exemplary evidence” (E), “Acceptable evidence” (A), or “Unsatisfactory evidence” (U) based on the evidence and/or reflections you have provided in your portfolio.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Potential Pieces of Evidence</th>
<th>E</th>
<th>A</th>
<th>U</th>
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<td><strong>Background Research</strong></td>
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<td>Student Scientist Info Sheet</td>
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<td>Brainstorming activities</td>
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<td>APA Citation Activities</td>
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<td>*Background Essay (and drafts if referred to)</td>
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<td><strong>Experimental Design</strong></td>
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<td>Experimental Design Worksheet</td>
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<td>*ISEF Rules &amp; Paperwork</td>
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<td>Data Analysis Assignment: Part 1</td>
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<td>Data Analysis Assignment: Part 2</td>
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<td>*Lab Notebook</td>
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<td>Research Report &amp; Abstract</td>
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<td>*Research Report (and drafts)</td>
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<td>*Abstract (as part of research report)</td>
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<td>Presentation of Research</td>
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<td>*Display Board</td>
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<td>Interview Practice</td>
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<td>Other Presentation Opportunities</td>
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<td>Reflections</td>
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<td>Thank you letters</td>
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<td>Reflection pieces for each of the above categories</td>
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<td>Overall Reflection Piece</td>
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*All starred items are necessary components in completing a qualifying science fair project.

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<tr>
<th>Achievement</th>
<th>Points</th>
<th>X</th>
<th>Total E/A/U’s</th>
<th>= Total Points</th>
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<tr>
<td>Exemplary</td>
<td>10 points</td>
<td>X</td>
<td></td>
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<tr>
<td>Acceptable</td>
<td>7 points</td>
<td>X</td>
<td></td>
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<tr>
<td>Unsatisfactory</td>
<td>5 points</td>
<td>X</td>
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Overall Grade = /60
THE SCIENCE FAIR PROCESS: OVERVIEW

1. **Brainstorming ideas** based on your interests and current events. Practice asking questions and forming hypotheses about the world around you until you find one idea that stands out.

2. **Researching** literature on the topic you chose. This will help you gain important background knowledge and give you insight as to what has been done before. Learning more about your question will open up even more questions and help you form educated hypotheses. Your research should use the internet, books, scientific journals, and magazines. You must be careful that your sources are credible.

3. **Writing a Research Plan** includes an introduction (background essay), your question & hypotheses or design goal, materials needed, and methods.

4. **Safety Review** is an important step in Science fair. Depending on your project, it may go through IRB or SCR review. A committee will look at your research plan to verify that it is safe for all parties involved.

5. **Submitting Paperwork** is essential to participate in any fair. There are many forms that need to be completed depending on what type of project you are doing.

6. **Experimentation/Engineering** is the fun part, but notice how much has to be done before you can even start. It is important to have a clear cut plan on how you are going to accomplish everything in just a few months.

7. **Recording Observations and Data in a Notebook** is important to help you remember what was done and to keep track of important details. You must include dates and be very detailed.

8. **Analyzing Data & Creating Graphs** helps you know if your hypothesis is supported or not. It also helps engineering projects know if they have met their design goals. You may be using excel or another graphing program.

9. **Writing a Research Report** details all parts of your experiment/engineering project. It includes an introduction (background essay) just like your research plan, but then in includes a detailed descriptions of what you did, shows graphs/tables of your data, discusses what they mean, and explains your conclusions based on your hypotheses.

10. **Creating a Display Board** is a way to visually represent your research report. Many things must be cut out because, generally, your research report is more detailed than what you can fit on your board.

11. **Practice Interviewing** will help you be more confident when the judges ask you questions.
Almost all projects can be divided into Experimental or Engineering. The main difference is that an experimental project has a hypothesis that it tests while an engineering project has a design goal. The Salt Lake Valley Science and Engineering Fair (SLVSEF) use these 12 categories. These are categorized based on the “type” of project they most often fall under. This is not always the case, though. For example, an “Energy: Chemical & Physical” project could very easily be considered experimental rather than engineering. A sub-category of experimental is a “Human Study.” These types of studies require human subjects. Depending on the project, human subject very often require parental consent (if under 18). Many different categories can qualify as a human study, but most commonly “Medicine & Health Science” or “Behavioral & Social Sciences.”
Brainstorming is a crucial aspect in defining a research topic. Many students have little or no idea what topic to focus his/her research. Brainstorming helps to establish the student’s interests, form questions, and narrow a topic. Even for students who know what topic he/she will research, brainstorming helps to access prior knowledge and form new inquiries to further the research.

Below are several types of brainstorming activities that should be used to help the student produce ideas. Brainstorming should be done in the student’s research notebook. Many of these we will do in class for points.

1. **Freewrite:** Freewriting is a timed activity in which you let your thoughts pour out onto the paper. Even if you have no thoughts or the thoughts in your head have nothing to do with the topic, you write that down! Freewrite has nothing to do with quality or style; spelling, punctuation, and grammar do not matter. This technique allows the researcher to purge his/her head of thoughts, which many times will create new connections about the topic. Establish a time limit (somewhere between 5 and 15 minutes), and quietly and continuously write about anything in your head. The following is an example of what a freewrite can look like:

   "This freewrite is supposed to be on the topic of photosynthesis the things I know about p.s. are that plants use this process to make sugar for food the sugar is glucose energy from the sun is used to drive the process and the plant needs water and carbon dioxide to make the sugar oxygen is released afterward to we can breath what else can I say about p.s. that will fill up these 10 minutes I don’t know anything else off the top of my head there are these plants in my yard called purslain I think that seem to grow everywhere there is a bare spot in the garden or grass I wonder if there is something different that those weeds do that make them able to grow in spots that other plants can’t I also notice that wherever these weeds grow there are ants and these other tiny little bugs maybe those insects have something to do with the plants being in those spots or with some other process the plant does…symbiosis?"

2. **Clustering:** Clustering is a great way to help organize thoughts and connect ideas within a topic. This activity starts with a blank piece of paper and the general topic circled in the middle of the page. Every idea or subtopic related to that topic is then branched from the general topic bubble into new bubbles. Connections between subtopics can be made as well by drawing lines between these bubbles a including a word or phrase that describes the connection. This can also be a timed activity.

3. **Classroom Talk:** This activity can take place in pairs, in collaborative groups and as a class. Classroom talks allow students to articulate their thinking and bounce ideas off of one another. Many new ideas and connections can be made using this technique. All students involved in the classroom talk should be equipped with a notebook to record any new ideas.

4. **Ideas Sheet:** It is a great idea to keep an “Ideas Sheet”. This piece of paper or page in your notebook is set aside only for concise ideas that where formed in your brainstorming sessions. Whenever a brainstorming activity is completed, review the ideas or connections made in that session and write down those ideas on your “Ideas Sheet”. This allows you to see all of your ideas in one place.
STUDENT SCIENTIST INFORMATION

Name: _______________________________________________________ Grade: ________________

Email: _______________________________________________________________________________

How do you find an idea that will inspire you to be a real scientist? Start by thinking about problems that interest you, favorite hobbies, classes, sports, & activities...

Things I like to do outside of school...

Examples: art, theater, sports, play games, music, build things, cooking, rock climbing

What career and educational goals have you considered?

Doctor, lawyer, environmental activist, forestry, river guide, fireman, teacher, psychologist, chemist

Refer to the Science Fair Categories document found in your workbook (page 8) for a list of project categories. List the categories that interest you....
What scientific issues interest you? Think about topics in the news.

Circle interests from this list and then add more below...

Global warming, bioengineering, cancer, spy communications, farming/agriculture, animals, alternative fuel, pollution (water, air), extinctions, environmental toxins, food safety, artificial food additives, homeopathic remedies, dietary supplements, engines, airplanes, radio frequency communications, magnets, GPS, weather monitoring, solar energy, wind energy, physics of skiing/snow-boarding (designing better skis), cell phones, radios, bicycles, computer programming, computer hardware, animal behavior, human behavior

Are you more interested in an engineering (design goal) or experimental (hypothesis) project? Why?

What science/math classes have you taken or are currently taking? Have you done a science fair project before? What was it?
Share any ideas you have for building, creating or improving something...engineering...

What project ideas do you have so far (not just a category; give a short description or question)? List at least 3 (use the back of this sheet for more space).

1.

2.

3.
RESEARCH BASICS

So now you have an idea or a few of them. How do you actually decide what you are going to do and how you are going to do it? The answer is research!

Here are a few reasons to do research:

1. **Be an expert!** Understand the background information relating to your topic. You need to know the vocabulary and concepts that are related to your basic idea to develop a proper plan. As you do more research, more questions and ideas will develop that will improve your original research idea.

2. **Know what has been done before.** You don’t want to flat out repeat an experiment with known results. If something has been done before, you can put a twist on it to make it your own: try it with a new demographic (teens from Utah), in a new context (Big Cottonwood Canyon), with a different species (moths instead of dogs), or a slightly different purpose.

3. **Know if it is possible.** You have a great idea, but you don’t know if it can be done. You need to do more research to make sure each step of your plan is possible and that you can affordably access all the materials necessary (your school, local universities, and businesses have many resources that can be used by student scientists if you ask).

Follow these steps to improve the efficiency of your research:

1. **Gain a broader knowledge!** So you want to do a project on depression, that is a broad idea to begin with, but you need to expand your knowledge even further to understand it from a scientific perspective. Go to websites that describe different types of depression, how it happens, how it is diagnosed, how it is medicated. The more information the better!

2. **Take good notes!** As you are learning more about the topic, take detailed notes. Specifically focus on new vocabulary words that can be used in future searches. Make a list of these new words and write down any questions that you may be able to develop into a project or that may guide future searches.

3. **Narrow your focus!** Now that you have a better general knowledge of the topic, start doing more specific searches on your project idea. Use scientific and specific vocabulary to start searching for similar studies and for ideas on how to do your project.

As the saying goes: don’t believe everything you read...especially on the internet.

Here are a few ways to find reliable sources:

- **Find primary sources!** Most of the information on the internet is just hearsay, like the game of “telephone” where someone whispers a statement into someone’s ear who then does the same. After it goes through a whole group of people, the original statement is often distorted. The same is true for the internet. Try your best to find the primary (original) source.

- Use the scientific name instead of the common name to get more scientifically driven websites. For example: *Drosophila melanogaster* instead of fruit fly

- Use Google scholar to find peer-reviewed articles and patents. Many articles will require purchase.

- A good rule of thumb is that you can trust it if it ends with a .edu or .gov. Be careful with .org because you may find very biased information that feeds into the agenda of that specific organization.
BE A BETTER GOOGLE-ER

The internet has vast amounts of information accessible by your fingertips from the privacy of your home, but do you know how to access it? There are many tips and tricks that can help you master the master of all search engines, Google.

<table>
<thead>
<tr>
<th>Operator</th>
<th>Example</th>
<th>What it does</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site:</td>
<td>Site:nytimes.com site:.gov</td>
<td>Only searches pages within that site or domain</td>
</tr>
<tr>
<td>Filetype:</td>
<td>Filetype:pdf</td>
<td>Searches for certain file types: pdf, doc, jpg, etc.</td>
</tr>
<tr>
<td>Intitle:</td>
<td>Intitle:depression</td>
<td>Only searches for articles with that word in the title</td>
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<td>..</td>
<td>2008..2012</td>
<td>Searches websites with numbers within that range</td>
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<tr>
<td>“ ”</td>
<td>“I am only passionately curious”</td>
<td>Searches for the exact phrase, not each of the words separately</td>
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<td>-</td>
<td>Bears -koala</td>
<td>Excludes term from search</td>
</tr>
<tr>
<td>~</td>
<td>~positive language</td>
<td>Will also search for synonyms for that word</td>
</tr>
<tr>
<td>OR</td>
<td>Spider silk OR strong polymers</td>
<td>Will show results for both term’s searches</td>
</tr>
</tbody>
</table>

WHEN WIKIPEDIA WORKS

You’ve probably heard never to use Wikipedia for academic research. Actually, Wikipedia is the perfect start to academic research because it allows you to read articles on nearly every subject which are often linked to related articles. This is a great way to quickly broaden your knowledge (see research step 1 on the previous page). Just please remember to follow these Wikipedia rules:

1. **NEVER EVER cite Wikipedia in your research papers.** Wikipedia is not a primary or even secondary source. Anyone can edit a Wikipedia article, so it can’t be assumed to be 100% accurate.

2. **Use Wikipedia to learn new technical vocabulary.** Even though you can’t cite what you learn in Wikipedia, you can use the new technical vocabulary words to conduct more scientific searches later.

3. **Use Wikipedia’s references.** People who write Wikipedia articles are supposed to cite their sources. You can see these sources by clicking on the numbered superscripts that are within the text or at the bottom of the article under “references”.
HELPFUL WEBSITES

News (a great way to find something current):

- 20/20 site http://abcnews.go.com/2020

Other great resources

- World Health Organization: http://www.who.int/en/
- PBS NOVA TV shows available online http://www.pbs.org/wgbh/nova/programs/
- PBS Scientific American Frontiers TV shows online http://www.pbs.org/saf
- NPR Science Friday http://www.sciencefriday.com/
- Science Buddies http://www.sciencebuddies.org/
- How stuff works http://www.howstuffworks.com/
- Discovery Channel online: http://www.dsc.discovery.com/
- Emedicine: http://www.emedicine.com/

Online Science Magazines

- Scientific American http://www.sciam.com/
- National Science Foundation: http://www.nsf.gov/
- Popular mechanics: http://www.popularmechanics.com/
- Make Magazine: http://www.makezine.com/
- Discover Magazine: http://discovermagazine.com/

Government sites

- Center for disease Control (CDC) http://www.cdc.gov/
- National Institute of Health (NIH) http://www.nih.gov/
- Environmental Protection Agency (EPA) http://www.epa.gov/
- Science.gov http://www.science.gov/
SCIENTIFIC NOTEBOOK

The scientific notebook is an important part of every project. It is the place to track the progress, collect data, and record observations. A detailed notebook will facilitate the writing of the research report. It will also be presented, with the report and display board, on the day of the science fair for judges to review.

Here are guidelines to follow:

- You should use a composition-style notebook. It should not have removable pages.
- The first page should have a title page with your name, project title, and school.
- The next few pages should be left blank. After your project is complete, you can fill them in as the complete table of contents.
- You should always write in blue or black pen, never in pencil.
- Always date every entry and use the same dating format throughout the notebook.
- Never scribble or white out anything you wrote. Instead, simply cross it out with a single line, like this, to ensure that everything, including your mistakes, remain accurately represented.
- It doesn’t need to be perfectly neat, just legible.
- You may tape or staple in data tables and graphs.
- Do not tear out pages or add pages in late.
- Be overly detailed in your observations. You never know what will be important later on.
ARTICLE REVIEWS

What is it?
In order to become an expert at your chosen topic, you need to know about previous and related research. That way, you can build upon known information instead of repeat it. You need to understand all aspects of your project and this requires a lot of research.

How do I do it?
You will start this assignment by searching for a reliable scientific source: a journal article or news source. Once you have found a good article, start to read it with pen and paper in hand. Jot down any notes or ideas that come to mind. For each reference write 3 descriptive paragraphs. The article review must also include an APA citation for the reference. All article reviews must be present in your portfolio.

How to write an APA Citation
Many of your sources will be electronic (websites). Fill in as much of the following information as possible (you sometimes have to hunt around to find the information; don't be lazy. If there is a page like http://www.somesite.com/somepage.htm, and somepage.htm doesn't have the information you're looking for, move up the URL to http://www.somesite.com/):


When an Internet document is more than one Web page, provide a URL that links to the home page or entry page for the document. For sources other than webpages, go to http://owl.english.purdue.edu/owl/resource/560/01/ and see “Reference List.” Another great resource is citation machine (http://citationmachine.net). Just fill out the simple questionnaire and it generates the citation in the correct format. Also, if there isn't a date available for the document use (n.d.) for no date and always use a hanging indentation.

Format & Grading
1. Name, Date, & Title
2. APA Citation: 3 points
3. Paragraph One (Summarization): 4 points
   a. Introduce the topic of the article by summarizing the issue or problem discussed in the article.
   b. Summarize the main research presented in the article and its conclusions
4. Paragraph Two (Analysis): 4 points
   a. What additional questions arose after reading this article?
   b. How could this study be continued or revised?
   c. Do you have any criticism about the science presented (controls, bias, subject, experimental design)?
5. Paragraph 3 (Application): 4 points
   a. How does this article apply to your project?
   b. How does this article help you with your project idea?

Total: 15 point
This article reported on a study about the reassuring power of a mother’s voice. Sixty-eight girls who had good relationships with their mothers were put through a couple of stressful events. Afterwards they were all comforted by their mothers through either text messaging, a phone call, or talking in person. Their cortisol (stress hormone) and oxytocin (bonding hormone) were tested before, during, and after the stressful events. The results showed that the girls were only comforted by the phone call and in person conversations. Text messaging did nothing to alleviate their stress. They did, however, find that they were comforted by their peers through text messaging.

This study focused on mother/daughter relationships and it would be very interesting to see if the same results would be found with son/father relationships. The article never said exactly what conversations were had between the mothers and daughters over text messaging, but it would be very interesting to compare them to the messages that their peers sent them. Mothers may not be as fluent in text messaging and that might affect their effectiveness.

I’m interested in doing a project on how technology affects relationships specifically looking at communicating through phone calls vs. text messaging. I didn’t realize that we are evolutionarily programmed to respond to a mother’s voice until I read this article and I wonder if the same could be said of friends’ voices as well. I’m also going to look in to how expensive it would be to test hormone levels like they did in this experiment. It may be very interesting to see how texting vs. talking affects different emotions in teenagers when conversing with their friends. I found this article to be very helpful and it gave me lots of ideas.
APA STYLE GUIDE

What is APA style?
APA stands for American Psychological Association and the style of writing is perfect for research since it focuses on the author and year of references. It is not the only style of writing a paper. MLA is another popular style, but it is not acceptable for research. You may, with approval from your mentors use an alternative research-appropriate style such as Chicago Manual, ACS, or AMA.

References
References are required for your science fair papers. These references appear on the last page of your research paper proper (meaning the references appear before any appendices you may have). These references are also cited within the text of your papers. In-text citations refer the reader to the appropriate resource on your Reference page. The following rules apply when creating your Reference page:

All entries must have a 0.5" hanging indention. This means that if the citation flows on to 2 or more lines, those lines are indented farther than the first line. This allows the reader to easily find the appropriate listing. These bullet points show a hanging indent.

APA Reference lists must not have any sort of bullets or numbering. There should be a blank line between entries.

Authors’ last names are listed first, followed by initials of first- or first and middle names. Do this for all authors of a particular work for up to and including seven authors. If the work has more than seven authors, list the first six authors and then use ellipses (…) after the sixth author's name. After the ellipses, list the last author's name of the work.

Capitalize all major words in journal titles.

Do not italicize, underline, or put quotes around the titles of shorter works such as journal articles or essays in edited collections.

If you have more than one article by the same author, single-author references or multiple-author references with the exact same authors in the exact same order are listed in order by the year of publication, starting with the earliest.

Italicize titles of longer works such as books and journals.

Reference list entries should be alphabetized by the last name of the first author of each work.

The word “References” must be listed at the top of your reference page. It must be centered and not in bold or italics or quotations.

When referring to books, chapters, articles, or web pages, capitalize only the first letter of the first word of a title and subtitle.

In-text Citations
APA format citations use the author’s last name and year of publication, for example (Bower, 2011). The last name refers the reader to the reference page for the listing “Bower”. The citation is entered BEFORE the period of the sentence.

If you are not using a direct quote or if you are referring to an entire book or article, you do not need to include a page number. All sources that are cited in the text must appear in the reference list at the end of the paper.
**Quotations**

When directly quoting from another work, you must include the page number in the in-test citation, for example (Bower, 2011, p. 35). The following are examples of how to arrange the needed information differently within your paper.

According to Bower (2011), "A familiar voice, but not instant messaging, may trigger a kind of hormonal reassurance in girls" (p. 35).

Bower (2011) found that "A familiar voice, but not instant messaging, may trigger a kind of hormonal reassurance in girls" (p. 35); a relief for many moms.

If the author is not named in a signal phrase, place the author's last name, the year of publication, and the page number in parentheses after the quotation.

He stated, "A familiar voice, but not instant messaging, may trigger a kind of hormonal reassurance in girls" (Bower, 2011, p. 35); a relief for many moms.

**Long Quotations**

For quotes longer than 40 words, it must be typed as a free-standing block of typewritten lines, and omit quotation marks. The quote should be double-spaced throughout and a hanging indent should be used. In this case, the citation comes AFTER the closing punctuation.

Bower’s (2011) study researched the following:

The daughters’ cortisol and oxytocin levels were tested before, during, and after the stressful events. The results showed that the girls were only comforted by the phone call and in person conversations. Text messaging did nothing to alleviate stress. (p. 35)

**Summary or Paraphrase**

If you are paraphrasing an idea from another work, you only have to make reference to the author and year of publication in your in-text reference, but APA guidelines encourage you to also provide the page number (although it is not required.)

According to Bower (2011), a mother’s voice, either in person or over the phone may biologically comfort a child, but more research must be done.

A mother’s voice, either in person or over the phone may biologically comfort a child, but more research must be done (Bower, 2011, p. 35).
APA CITATION ACTIVITIES

#1. Create a reference listing of the following information:

A. Title: Ancient Saharan Head Cases
   Author: Bruce Bower
   Type: online article, http://www.sciencenews.org/view/generic/id/333452/title/Ancient_Saharan_head_cases
   Date: August 17th, 2011

B. Title: 13-Year-Old Designs Super-Efficient Solar Array Based on the Fibonacci Sequence
   Author: Rebecca Boyle
   Date: August 19, 2011

C. Title: Grizzlies Return, With Strings Attached
   Author: Jim Robbins
   Type: online newspaper article, http://www.nytimes.com/2011/08/16/science/16grizzly.html?_r=1&ref=science
   Date: August 15, 2011

D. Title: Evolution of Infectious Disease
   Author: Paul W. Ewald
   Type: Book
   Chapter Title/Pages: When Water Moves like a Mosquito/pp. 67-86
   Date/Location/Publisher: 1994/New York, NY/Oxford University Press, Inc.
#2. Create 2 variations of in-text citations for the following from your reference listings on the previous page.

A. From the article: *Ancient Saharan Head Cases* by Bruce Bower
   “Signs of renewed bone growth around the rims of these cranial openings indicate that the men, who lived roughly 2,000 years ago, survived the surgical procedure.”

1. ________________________________________________________________
  ____________________________________________________________________
   ________________________________________________________________
   __________________________________________________________________

2. __________________________________________________________________
   __________________________________________________________________
   __________________________________________________________________
   __________________________________________________________________

B. From the article: *13-Year-Old Designs Super-Efficient Solar Array Based on the Fibonacci Sequence* by Rebecca Boyle
   Thirteen-year-old Aiden Dwyer determined “ratios representing the spiral pattern of the leaves and branches on an oak tree, using a cylindrical double-protractor tool of his own design. Then he copied the pattern using a computer program, and built an oak tree-shaped solar array out of PVC pipe.”

1. ________________________________________________________________
   __________________________________________________________________
   ________________________________________________________________
   __________________________________________________________________

2. __________________________________________________________________
   __________________________________________________________________
   __________________________________________________________________
   __________________________________________________________________
RESEARCH PLAN BASICS

Purpose of a research plan:

- It is required as part of the paperwork needed for the regional fair and the International Science & Engineering Fair (ISEF).
- If necessary, it will be reviewed by the SRC or IRB and approved before experimentation begins.
- You need a specific, clear-cut plan, where you anticipate all of the variables and problems before you begin experimentation.

Important points in writing a plan:

- Research, research, research!!! Background research to find known and unknowns on the topic.
- It must be in APA format. Read the following for further details:
  - Go to Online Writing Lab at Purdue (OWL):
    [http://owl.english.purdue.edu/owl/section/2/10/](http://owl.english.purdue.edu/owl/section/2/10/)
  - See APA Style Guide (pg. 21)
- Must be written in 3rd person, passive voice
  - Do not use these words: I, me, we, you, your, us, my, mine, yours
  - Instead of using yourself as the subject of the sentence, make the science the subject.
    EXAMPLE
    BAD: I will pour 30 mL of phosphoric acid into the beaker.
    GOOD: 30 ml of phosphoric acid will be poured into the beaker.
- Use complete sentences! No direction-like lists.
- Write methods in future tense.
- Be VERY, VERY DETAILED! Somebody should be able to read your plan, follow it, and come up with the exact same results that you do. It is like a recipe...you cannot leave out any steps or your cookies will taste gross!
- Do not use contractions: do not instead of don’t, cannot instead of can’t, etc.
- Your references must be cited BOTH on a reference page AND in text.

The Research Plan includes:

<table>
<thead>
<tr>
<th>Experimental Projects</th>
<th>Engineering Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Title Page</td>
<td>1. Title Page</td>
</tr>
<tr>
<td>2. Background Essay (Introduction)</td>
<td>2. Background Essay (Introduction)</td>
</tr>
<tr>
<td>3. Question &amp; Hypothesis</td>
<td>3. Design Goal</td>
</tr>
<tr>
<td>5. Methods</td>
<td>5. Methods (Construction &amp; Testing)</td>
</tr>
<tr>
<td>6. Reference List</td>
<td>6. Schematics (Illustrations of design)</td>
</tr>
<tr>
<td></td>
<td>7. Reference List</td>
</tr>
</tbody>
</table>
**Standard Research Paper Format**

The format should follow this order: Title Page, Abstract, Main Body, Reference Page, Appendices if needed.  
Size 10-12 font; 1 inch margins; Double spaced; Times New Roman font or similar  
Use a Page Header throughout that includes the Title (left aligned) and the Page Number (right aligned)  

**Title Page:** in center of page (double spaced)  
Title:  
Subtitle  
Author Name  
School

**Abstract (when required):**  
- Simple, concise summary of the main points of your research.  
- The word “Abstract” centered at the top of the page (no bold, italics, etc)  
- Do not indent  
- One paragraph, double spaced, 150-250 words

**Main Body**  
- Type and center the title, at the top of the first page, do not bold or increase font  
- Text should be double-spaced with all sections following each other without a break  
- Use in-text citations to cite your references  
- Format tables and figures appropriately

**References Page**  
- Center the title “References” at the top of the page (plain font: no bold, italics, etc)  
- Double-space reference entries  
- Hanging Indent all entries that use more than one line of text  
- Order entries alphabetically by the first word in each citation (author’s last name)

**Other citation formats.** Note that there are other formats for citing, including Chicago Manual Style, AMA, and ACS. These formats are acceptable to use as long as it makes sense with the topic of your paper and as long as you are consistent throughout your research and writing. Please check with your instructors if you wish to use a format different from APA.
THE BACKGROUND ESSAY INSTRUCTIONS

• First portion of research plan – the introduction
• Should be at least 5 paragraphs depending on scope of project
• Serves as the introduction to both research plan and, later, your research report
• Purpose:
  o To give important details about your project to the reader
  o To show to the reader that you are an expert in the subject
  o To explain the significance of your project
• Your background essay should include:
  o Important studies that have been done relating to your project (include citations)
  o Known statistics
  o Relevant definitions of subject-specific lingo
  o Important concepts that the reader must understand before they can understand your project
  o Data that supports the idea that your project is important
• Citations
  o References are required
  o They should be cited in-text by using author’s last name (or organization’s name) and year.
    ▪ Example: The study showed that . . . (Smith, 2009).
  o They should also be included in your reference list
    ▪ If you have a reference in your list, it must also be referenced in text
    ▪ Must be in APA format unless other format is approved by your teacher
    ▪ Use citationmachine.net
• Must be in 3rd person passive
  o Do not use these words: I, me, we, you, your, us, my, mine, yours
  o Instead of using yourself as the subject of the sentence, make the science the subject.

EXAMPLE
BAD: I will pour 30 mL of phosphoric acid into the beaker.
GOOD: 30 mL of phosphoric acid will be poured into the beaker.
EXPERIMENTAL DESIGN

When approaching an experimental project, it is important to design the experiment in a way that will answer the question you are attempting to answer. In these types of projects, we are interested in analyzing data generated from experimentation. This data should be interpretive, therefore, it is necessary to take the time to design an experiment that is organized, representative, and efficient. This design starts first with the good, original question. It is then necessary to formulate a hypothesis. You will be forming a

RESEARCH HYPOTHESIS.

Research Hypothesis: A research hypothesis is more than your “educated guess”. It is more than your “prediction” of what will happen. A research hypothesis includes a hypothesis, method, and prediction. It can be in the form of a “if, and, then” statement like this:

“If [HYPOTHESIS], and [METHOD], then [PREDICTION].”

Another way to think of this statement is: “If X, and Y is performed, then Z will happen.”

Your research hypothesis does not have to be a single statement as shown above. It can be an entire paragraph, as long as the 3 parts are present: a tentative hypothesis, a method and a prediction.

Design an experiment using the question: How does the color of light affect plant growth?

1. How do you want to set up this experiment? Give a brief description of your method.

______________________________________________________________________________________

______________________________________________________________________________________

______________________________________________________________________________________

2. What do you think will happen in this situation? [PREDICTION]

______________________________________________________________________________________

______________________________________________________________________________________

______________________________________________________________________________________

3. Why did you make that prediction? [HYPOTHESIS]

______________________________________________________________________________________

______________________________________________________________________________________

______________________________________________________________________________________

4. What will you do to get from your prediction to your hypothesis? [METHOD]

______________________________________________________________________________________

______________________________________________________________________________________
5.  Now, write a single-sentence RESEARCH HYPOTHESIS:

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Variables

Variables: While writing your research hypothesis, you must take into account what variables might affect your experiment. A variable is something that can affect the outcome or the data of the experiment. There are many types of variables.

- **An Independent Variable (cause)** is the variable that is measured by the experimenter to see an effect on another variable. Your project should have ONE independent variable and it is represented as the \textit{x-axis} on a graph.

- **A Dependent variable (effect)** is a variable that changes as a result of the independent variable changing. For example, a child’s height (dependent variable) depends on her age (independent variable). It is represented as the \textit{y-axis} on a graph.

\textit{NOTE: Not all experimental projects have independent and dependent variables. Some try only to find a correlation between two variables.}

- **Controlled variables** are everything else that can change but is held constant as to not affect the results of the experiment. For example, if you are testing the effect that drinking caffeine has on typing speed, you would need to control many variables. The independent variable is the caffeine and the dependent variable is the typing speed. You would need to control the typing prompt (it should be the same for everyone), the time between drinking the caffeine and typing, and the amount of caffeine consumed among other things.

Testing Groups: Generally, experiments will have both an experimental group and control group. The control group helps identify experimental effects. It serves as a basis for comparison. The experimental group provides the data that will either support or refute the hypothesis. For example, in an experiment where the prediction is that “Taking vitamin C may prevent the common cold,” the experimental group would take vitamin C and the control group would take an inert pill (placebo) that they believed was vitamin C. That way the experimenter can see if there is a real difference between the two groups.
Now, refer back to the light and plant growth experiment and answer the following questions:

6. What is the independent variable? _________________________________________________

7. What is the dependent variable(s)?__________________________________________________

8. What other variables do you need to account for?______________________________________
____________________________________________________________________________________
____________________________________________________________________________________

9. What are the experimental and control group(s)?
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Sketch a graph with fake data showing the results of this hypothetical experiment. Remember to properly label the graph and axes. Indicate what units were used.
MATERIALS & METHODS OUTLINE

Directions: On a separate piece of paper, please complete the Experimental or engineering project outline that follows as it applies to your project (do not complete both of them). Include the headings that are numbered. You will use this simple outline to write our your “materials & methods” portion of the research plan in paragraph form.

EXPERIMENTAL PROJECT

1. **Question & Research Hypothesis**: If you have multiple hypotheses, list as H1, H2, etc.
2. **Materials**: Create a specific, bulleted list. You do not need to include the obvious: computer, pencil, paper.
3. **Subjects**: describe if applicable
   - Ages?
   - Gender?
   - How many (you need 30 subjects/group)?
   - How/where are you recruiting subjects?
   - Information about protection of privacy: Will identifiable information be collected? Will data be confidential or anonymous?
   - Informed consent: Describe how you will inform participants about the study. Remember to include that their participation is voluntary and they have the right to stop at any time.
4. **Variables**: describe the ones applicable
   - Independent (cause)
   - Dependent (effect)
   - Controlled Variables
5. **Experimental Group**: describe if applicable
6. **Control Group**: describe if applicable
7. **Data**: What type of data will you collect? How will you display it? Include example graphs.
8. **Methods**: Write a list of the steps you are going to follow. It needs to be detailed like a recipe so that others could duplicate your work.
9. **Risk and safety**: Identify any potential risks and safety precautions to be taken.

ENGINEERING PROJECT

1. **Design goal & purpose**
2. **List of materials**: Create a specific, bulleted list. You do not need to include the obvious: computer, pencil, paper.
3. **Construction steps**: It needs to be detailed like a recipe so that others could duplicate your work.
4. **Testing the prototype/program**: What data will be collected? Draw example graphs.
5. **Schematic(s)**: In detail, draw what the prototype will look like. Include measurements, if applicable. If it is a computer program, draw the wireframe (it can be hand drawn or you can use an online program to develop the wireframe).
6. **Risk and safety**: Identify any potential risks and safety precautions to be taken.
Proper and detailed planning can be the difference between a successful project and failure. This assignment is to help each student plan out important details and dates related to the successful completion of their project.

**Step 1:** Create a very detailed to-do list in your scientific notebook. Try to put items in chronological order from what you must do first to what you will do last. Include everything from speaking to certain individuals to collecting materials to construction steps. Include amounts, locations, people, everything.

**Step 2:** After your to-do list has been approved. Put each item in your to-do list on the calendar below (items may be abbreviated). Many items will be dependent on availability of resources or scheduling appointments with mentors. Please list these items with a range of dates if you are unsure of an exact date. Each week should have at least one item. Remember holidays and previous commitments. *Obviously, your project can’t be planned perfectly and there are many outside variables that will influence direction of your project, but this is just a plan and plans can be changed, if necessary.* You may type the calendar on a separate page if you prefer a different format or need more space.
ISEF RULES & PAPERWORK

PAPERWORK
Complete the “Rules Wizard” at https://apps2.societyforscience.org/wizard/index.asp and then check which forms you need for your project on the list below. Print off those forms and fill out all information that you can, including signatures, dates, name, addresses, project title. Please type in information before you print or write legibly with pen. The rules and forms can be found at https://student.societyforscience.org/forms

Required for ALL projects
_____ Form 1: Checklist for Adult Sponsor/Safety Assessment Form
_____ Form 1A: Student Checklist (NOTE: Put the end date as 5/10. Do NOT write in a start date yet.)
_____ Form 1B: Approval Form

Special forms
_____ Form 1C: Regulated Research Institutional/ Industrial Setting Form
_____ Form 2: Qualified Scientist Form
_____ Form 3: Risk Assessment Form
_____ Form 4: Human Subjects Form
_____ Sample Informed Consent Form
_____ Form 5A: Vertebrate Animal Form A
_____ Form 5B: Vertebrate Animal Form B
_____ Form 6A: Potentially Hazardous Biological Agents Form
_____ Form 6B: Human and Vertebrate Animal Tissue Form
_____ Form 7: Continuation Projects Form

NOTE: You do not need to complete an abstract at this time

RULES & GUIDELINES
Read through the ISEF Student Handbook and ISEF Rules and Guidelines booklet. Highlight the parts that are relevant to your project so that they are easy to reference in the future. Use the Handbook and the Rules & Guidelines booklet to answer the following questions. It is your responsibility to read and understand the rules. Your project must be in accordance with the rules outlined in the booklet.

1. Scientific fraud includes the following practices: ____________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

2. What is an Adult Sponsor? ____________________________________________________________
____________________________________________________________________________________
*Do I need one? ______________ Who? ______________________________________________________

3. What is a Qualified Scientist? ________________________________________________________
*Do I need one? ______________ Who? ______________________________________________________

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4. What is a Designated Supervisor? __________________________________________________________

*Do I need one? _______ Who?_____________________________________________________________

5. IRB stands for _______________________________________________________________________

6. When and why is an IRB committee required? _____________________________________________

_____________________________________________________________________________________

*Do I need an IRB review? ________________

7. SRC stands for _______________________________________________________________________

8. When and why is an SRC committee required? _____________________________________________

_____________________________________________________________________________________

*Do I need an SRC review? ________________

9. What qualifies as a continuation project? ___________________________________________________

_____________________________________________________________________________________

10. When must a risk assessment form be used? _______________________________________________

_____________________________________________________________________________________

*Do I need one? _______ What are my potential risks?_______________________________________

_____________________________________________________________________________________

11. Am I using any potentially hazardous biological agents? _________________________________

*What agents? ___________________________________________________________________________

12. Do I need access to equipment or a lab outside of our school building? _____________________

*What equipment or lab requirements? ______________________________________________________
ENGINEERING SPECIAL CONSIDERATIONS

- You will have a **design goal** instead of a question and hypothesis.
- A good design goal will consider the following:
  
  - Must be original – do not recreate something that has been done before. You can, however, make important modifications to something that already exists. For example:
    - Change the size: make it smaller, bigger
    - Make it more user friendly
    - Make it more affordable
    - Alter the purpose slightly
  
  - Must have a purpose - You cannot create something just because it would be cool, it needs to fill a need.

- There are many types of engineering projects and not all build devices. A few examples:
  
  - Computer program
  - Mechanical Engineering
  - Electrical Engineering
  - Mathematics - developing an algorithm

- You do not have to create a completely functional prototype. You only need to present a **proof of concept**. It could be scaled back and built with whatever materials are available, but still must prove that your concept will work. Your prototype needs to be tested and improved and retested.

- Your research plan will include schematics or drawings of what you plan to create. The schematics can be hand drawn or you can use a program to make more sophisticated designs. If you are developing a computer program, your schematics will show the logic behind your program in the form of a wireframe.

- Testing prototype: You will need to determine if your prototype meets your design goal by performing tests. This may come as a cost analysis (how much more affordably can you make your prototype compared to your competitor?) or you may have to determine its accuracy or speed. You should collect data and analyze it to determine if your design goal has been met or if further improvements can be made. If your prototype does not perform as expected, make improvements and retest.

- If you believe you are creating something that can eventually be sold, you will need to look into the process of developing a patent **before** you compete at a science fair.
HUMAN STUDIES SPECIAL CONSIDERATIONS

- In order to calculate statistical significance, you need at least 30 subjects per population. That means if you are comparing males and females, you need 30 male subjects and 30 female subjects. If you are comparing left and right handedness between males and females, you will need around 120 subjects: 30 left-handed males, 30 right-handed males, 30 left-handed females, and 30 right-handed females. Of course, you won’t know who is left- and right-handed before testing begins, so aim to recruit at least 120 subjects. It is often difficult to recruit the ideal number. Remember, if you are chosen to advance from the science fair, you can continue collected data until the next fair.

- You will need IRB approval before you start experimentation. The IRB will review your research plan and paper work for any safety concerns. This includes the physical and emotional safety of the student scientists and the subjects.

- Whenever personal information is collected, the subjects must be de-identified to keep the information confidential and the identities anonymous.
  - Each subject is assigned a code (number, letter, or combination) to be used with their information rather than a name
  - Only a teacher can have access to the student names that correspond to the codes
  - The student scientist should never know the names that correspond to the data

- Forms that must be included (not all inclusive):
  - Form 4: Human Subjects form
  - Sample informed consent form: Fill out empty fields by typing or writing nicely in pen. Highlight the section to be signed so that it is easily seen
  - Parent Consent Letter: Attach this letter to the informed consent form
  - Research plan with questionnaires or surveys: Surveys must be finished and included in the plan before approval can be made

- Recruiting subjects:
  - After you determine what types of subjects you need (i.e. age, gender, etc), you must determine the best way to recruit the subjects.
  - Generally, the students scientist needs cooperation from a teacher or many teachers in order to use their various classes as subjects
    - Be considerate of the time commitment you are asking from the teacher.
      He/she has curriculum planned far in advance so be flexible in the time you are asking of them.
    - To ask for teacher help, write a professional letter (similar to the parent letter) that explains your project and time commitment and attach your research plan (including any testing materials such as surveys). It is preferable to give the teacher your letter and plan in person, answer any questions they may have, and give them time to read the materials and make a decision.
    - If the teacher does agree to help, be very appreciative and understanding. Give them the proper number of consent forms (parent letter stapled to highlighted consent form) and collect them from them on a regular basis until you reach your testing date.
    - Write a thank you letter and deliver a complete research report.
EXAMPLE PARENT CONSENT LETTER

All ISEF consent forms should be attached to a letter that more fully explains any HUMAN STUDY project.

Dear Parent/Guardian,

I am a junior at Yourschool. I am working on a science fair project that will require over 100 adolescent subjects and am hoping to test your student. This is year-2 of this project. The purpose is to study how air pollution may affect short-term changes in lung capacity in teens. Since the project is so closely related to the curriculum in Biology and Health classes, testing will take place in Ms. Curie’s classes.

What is involved in testing?

a. On approximately 10 different days (when air quality is good, poor or very bad), Ms. Curie will ask test subjects to complete a 2 minute survey to see if they are experiencing any cold related symptoms.

b. After completing the survey, test subjects will be asked to blow into a “peak flow meter” (three times) in order to measure their lung volume. This will require ~5 minutes.

Safety:

a. A safety committee has evaluated and approved this study.

b. Subjects will be de-identified, meaning I will not know which data belongs to which subject (only Ms. Curie will have access to this information).

c. Disposable, single use mouth pieces will be used on each test day. The mouth piece will be attached to a Tru-Zone Peak Flow Meter.

The device is commonly used by asthmatics, for self monitoring of lung volume.

d. Testing will occur during Biology and Health classes, under the supervision of Ms. Curie.

Educational Value:

Students will learn about the respiratory system and pollution. Results from the study will be shared with the Yourschool’s student body during the annual spring Science Symposium.

If you are interested in giving your student permission to participate, I will need consent (signatures) on the attached form (see highlighted spaces). The final research report will be made available to interested parents and students.

Also, if you do give your student consent to be a part of my study, please do not tell them the purpose of this study because it may throw off my results.

If you have any questions, please contact the research coach for this project, Mr. Newton scifair@yourschool.org or Ms. Curie (Biology teacher).

Thank you very much and have a great day.

Sincerely,

Galileo Galilei

Yourschool Student Scientist
MANAGING DATA IN EXCEL

If your project will involve data collection, you will need to create an excel spreadsheet. Basic steps:

1. **Take a look at your research plan and think about the data that you will be collecting.** Create a template sheet that has labels for the columns and rows so you have a place to put your data, once you collect it. Periodically print the spreadsheet and tape the sheet into your project notebook for easy data collection out in the field.

2. **Columns vs. Rows:** Typically, you will list the subjects or different samples as different rows. The columns will be used to denote dates, measured variables, or separate trials.

3. **Coding Data:** For most types of analyses, your data must be in numerical format. That means only numbers should be in the data cells (units should be placed in the cell that labels the column). For non-numerical data, you can provide a code that changes the data into numbers. For example: gender is usually coded as 0=female and 1=male. Similarly, no=0 and yes=1.

4. **Human subject experiments:**
   a. Come up with a system to “deidentify” your subjects. This means you should use a code instead of a name to keep their personal information private. Only a teacher should have the list that shows the name associated with the code.
   b. Create a code that is easy to understand and reveals information important to your study. Include gender, age or other details in the code if they are important to your project.
      i. Example: ML1 could be male, left-handed number 1

5. **Bacterial study:**
   c. Give each Petri dish an identification number (LB-1-NBath)
   d. Track sampling locations and dates
   e. Track incubation schedule for each sample
   f. What are you studying---
      i. counting colonies: date columns in your sheet for each day you will evaluate and count colonies...record counts for that day
      ii. +/- growth for a certain type of bacteria

6. **Engineers**
   g. Create a spreadsheet to track test results
      Example: Airplane study. Track test flights, changes to airplane, control flights,
   h. Treat each change to the plane like a human subject---adding columns to record results from different types of analyses

7. **Environmental study**
   i. Set-up sheets to include sampling locations, if you are testing several variables.
   j. Treat each sample like a human subject---adding columns to record results from different types of analyses
DATA ANALYSIS

It is not enough to collect data. The numbers mean nothing without proper statistical analysis. Here is a list of some common forms of analysis, although it is not completely comprehensive.

**Average:** Add all the data and divide by the number of data points. The average helps show the big picture, but the picture is incomplete without the standard deviation.

**Standard Deviation:** The standard deviation shows the spread of data within an averaged group. For example, let’s say we calculate the average test score out of a possible 10 for 2 classes. The first classes scores are 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and the second class had scores of 5,6,5,6,5,6,5,6,5,6. Both classes have an average score of 5.5, but that doesn’t tell the whole story. One class had a huge variance with scores ranging from 1 to 10 which are calculated as a standard deviation of 3. The second class only varies between 2 values. It has a standard deviation of 0.5. In a bar graph, standard deviation is shown as error bars.

**Correlation:** If two variables have a strong relationship, they are said to be highly correlated. It is very important to note that correlation does not equal causation. Just because they are related does not mean one causes another. For example, ice cream sales are highly correlated with shark attacks. Does that mean that sharks like the taste of ice cream? No. It can be more simply explained that people buy more ice cream when they are at the beach. When comparing two variables on a scatterplot, the correlation can be discovered by applying a regression or best-fit line. An R² value will be given with each regression line. A value of 1 or -1 indicates a perfect correlation. As a value approaches 1 or -1, it is more closely correlated. A positive correlation means that the two variables move in the same direction while a negative correlation is when the variables move in opposite directions.

**T-test:** It is not enough to say that 2 numbers are different. How different are they? Is it significant? In science there is a way to determine if the difference between two groups is significant by performing a t-test. The result from a t-test is a p-value which indicates the probability that the results happened by chance. For example, if the p=0.05 then there is a 5% likely the results happened by chance and, inversely, 95% likely that the results did not happen by chance. Scientists generally consider p<.05 a statistically significant result. Even better than p=0.05 would be a p=0.01 which means that the results were 99% likely the results did not happen by chance. This would be considered “highly significant.”

**ANOVA:** ANOVA stands for Analysis of Variance. It is similar to a t-test in that it determines if there is statistical significant through a p-value. The difference is that ANOVA can test multiple groups whereas a t-test can only check for significance between 2 groups. Although ANOVA can tell you if one group is statistically different from the other groups, it cannot tell you which group that is.

**Chi-squared:** A chi square (X²) statistic is used to investigate whether distributions of categorical variables differ from one another. Basically categorical variable yield data in the categories and numerical variables yield data in numerical form. Responses to such questions as "What is your major?" or Do you own a car?" are categorical because they yield data such as "biology" or "no." In contrast, responses to such questions as "How tall are you?" or "What is your G.P.A.?" are numerical.
TYPES OF GRAPHS

Line Graph

A line graph displays information in a series of data points that each represents an individual measurement or piece of data. The series of points are then connected by a line to show a continuous visual trend in data as the independent variable (x-axis) changes. The y-axis represents the dependent variable. Multiple lines can be used to compare separate sets of data.

Bar Graph

The bar graph is a common type of graph which consists of parallel bars or rectangles with lengths that are equal to the quantities that occur in a given data set. The bars can be presented vertically or horizontally to compare information. Bar graphs are used for plotting discontinuous (discrete) data. Discrete data contains discrete values and are not continuous. It is useful for numerical comparisons. When bar graphs represent averages, error bars should be used.

Scatterplot

Scatter plots are similar to line graphs in that they use horizontal and vertical axes to plot data points. However, they have a very specific purpose. Scatter plots show how much one variable is affected by another. The relationship between two variables is called their correlation. The closer the data points come when plotted to making a line (called a regression line or best-fit line), the higher the correlation between the two variables, or the stronger the relationship. A perfect correlation is indicated by an $R^2$ value=1 or -1. The closer the number is to 1 or -1, the stronger the correlation, or the stronger the relationship between the variables.

Pie Graph

A pie graph is a circle divided into sections which each display the size of a relative piece of information as a percentage. Each section of the graph comes together to form a whole. In a pie graph, the length of each sector is proportional to the percentage it represents. It is used when breaking down separate components as part of a whole.
Instructions: Read the “Managing Data in Excel”, “Data Analysis”, and “Types of Graphs” informational sheets before you move on. Next, read the case studies and answer the questions relating to the studies.

Case Study 1: You are curious how air pollution affects plants. You know that Sulfur Dioxide in the atmosphere can produce acid rain so you suspect that the more sulfur dioxide in the air will make the plants more acidic. Acidity is measured by pH. The lower the pH means that it is more acidic. Atmospheric SO₂ is measured in parts per million (ppm). You will test the SO₂ in the air and take a tree bark sample on the same day. The tree bark will be crushed up and then made into a solution in which you will test the pH.

1. What is your question and hypothesis (you may have more than one)?

2. Based on your hypothesis, what type of question are you asking? Choose one.
   a. Is group A different than group B?
   b. When A increases, does B change too?

3. Based on the answer to question 2, what type of statistical analysis will you be performing?

4. What is your independent variable (the one that isn’t changed by other variables)?

5. What is your dependent variable(s) (the one that changes depending on the independent variable)?

6. What other variables will you measure (sometimes you measure variables such as age or race to see if they possibly have an effect even though they aren’t related to your main hypothesis)?
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Case Study 2: You make an observation about your Facebook friends. It seems as though the girls post more often than the boys. You are curious about whether or not this is a common phenomenon or if your friends are the exception to the rule. You plan on testing this by handing out a survey that will track people’s Facebook activity over the course of a week. You will ask them how long they are on Facebook each day which will be measured in hours and how often they post a status, picture, or video each day. You will need at least 30 subjects for each group which means you will need at least 60 subjects.

1. What is your question and hypothesis (you may have more than one)?

2. Based on your hypothesis, what type of question are you asking? Choose one.
   a. Is group A different than group B?
   b. When A increases, does B change too?

3. Based on the answer to question 2, what type of statistical analysis will you be performing?

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**DATA ANALYSIS ASSIGNMENT: PART 2**

**Your Project**

*Instructions:* Answer the following questions as they apply to your project. If you have an engineering project, you will most likely need to do prototype testing in which you collect data and perform analysis. Also, some projects will not have independent and dependent variables or might require different types of analysis than those typically performed. In any case, please answer those questions which apply to your project and write an explanation for the questions which do not apply.

1. What is your question and hypothesis (you may have more than one)?

2. Based on your hypothesis, what type of question are you asking? Choose one.
   a. Is group A different than group B?
   b. When A increases, does B change too?

3. Based on the answer to question 2, what type of statistical analysis will you be performing?

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RESEARCH REPORT INSTRUCTIONS

Research reports are similar to the research plans you have already written. You use the same introduction, the same materials, and the methods are pretty much the same, except they have been changed to past tense. There are a few additions that should be included in your report, but your research plan is a great start.

RESEARCH REPORT

- **Title page**: includes the name of the project, year, your name, and your school’s name.

- **Table of contents**: IF your paper is long enough, a table of contents is a great addition.

- **Introduction**: This is the same as your background essay you wrote for your research plan. You should cite (APA format) at least 5 different references. Feel free to add upon or improve your introduction from your research plan to be better aligned with your report.

- **Materials & Methods (Experimental design)**: You already wrote materials and methods for your research plan, so you need to just change the entire section to be past tense to describe what you did which means you will need to add or change some portions to accurately describe your testing process. Be descriptive but concise.

- **Results**: Tables, graphs, photographs and/or drawing that report the results from the experiment or engineering prototype. Provide results in an order that describes the process of discovery or construct. Include a clearly labeled caption for each figure and table.

- **Discussion**: Discuss the meaning of the data. What do the results say about your hypotheses or design goal? Restate the hypothesis and design goal so the reader can easily follow. What problems did you run into? How could you avoid these problems in the future? How will you continue this study?

- **Conclusion**: Does the data support your hypotheses? What does it mean? If you have a conclusion section, it should summarize the main findings in your discussion in a few sentences or bulleted points. *Never* say that your data PROVES or DISPROVES the hypothesis. Instead say that the data supports or SUPPORTS or REFUTES the hypothesis.

- **References**: At least 5 in APA format.

- **Appendices (if needed)**: If you have any document that you have referenced anywhere else in your report, you should include it as an appendix. This includes any questionnaires that you may have used, important large data tables, detailed schematics, large code, or a glossary to provide several important definitions important to understanding your project.
Proper format for figures and tables:

- Graphs should always have a simple descriptive title. The x- and y-axis should also be labeled with SI units stated. The x-axis should be the independent variable and the y-axis should be the dependent variable (if applicable). Graphs should be labeled as figures with short caption.
- Pictures should be labeled as figures with short captions and should also give credit to photographer (photo taken by).
- Tables should be labeled as tables and should have a separate numbering system (There can be both a Table 1 and a Figure 1). It should be properly titled and units should be shown.
- Each caption should be short but be a stand-alone description of the data i.e. they shouldn’t have to read through your entire discussion to understand the graph. It should be labeled as a figure (graph, picture, diagram) or table. The figures and tables should be numbered in order that they appear in the text.

EXAMPLE:

Figure 3: This graph shows the correlation between handedness and Math scores. $R^2 = 0.0417$ which indicates no correlation between being right-handed and a higher math score as hypothesized.
**HOW TO WRITE AN ABSTRACT**

*(SLVSEF Instructions)*

An abstract is required for all projects advancing to the regional level. It is basically a short description of your project: what your research hypothesis was, what experiments you conducted, and the results you saw. It should be around 200-250 words depending on the requirements for the particular competition.

- A brief, written explanation of the research project, consisting of a succinct description of the project’s purpose, the procedures followed, the data collected, and the conclusions reached.

- A clear and simple summary statement of the main points of the experiment that is self-contained, meaning that it must make sense all by itself.

- The abstract must focus on the current year’s research and give only minimal reference to previous work.

- Include all of the following:
  - *Purpose of project / experiment*
    - In a sentence of 25 words or fewer, explain the reason for your research project and hypothesis.
  - *Methods of research*
    - Explain in a sentence or two how you researched your topic. What methods and resources did you use?
  - *Data/Observations*
    - What type of data did you collect and what difficulties did you encounter as you conducted your research.
  - *Conclusions/Applications*
    - Explain in a sentence or two what results your research produced. What is your conclusion and are there any applications for your project?

**Example Abstract**

In June 2010, a Chevron pipeline leaked over 500 barrels of oil into Salt Lake rivers and creeks. This study investigated the impacts of the oil spill on the microbial life of the affected sites. Tests were conducted to quantify the microbial communities in these waters, analyze differences in bacterial species across the ecosystems, and compare the results with one another as a function of time. Also, inorganic analyses of water samples were conducted to better explain the microbial data. Results revealed that the oil spill had a variety of impacts on the microbial life in the sites tested. Some samples displayed a lack of thriving microbial species, a possible result of their exposure to large quantities of volatile compounds. Other samples revealed the gradual revival of microbial communities following the spill. A prominent find was the rise of new species at 900 S. Storm Drain which correlated with the decline in volatile hydrocarbon compounds. Further research will identify these species, as their presence may be a sign of oleophilic bacterial biodegradation.
**Science Fair Display Instructions**

**What to display on your poster**
Your science fair display is a visual representation and summary of your research report. It includes all sections of your report although they may be shortened depending on space limitations. Font size should be big enough to read from a distance of 3 feet; at least 14.

**Introduction:** background essay, with 5 references (cited in the text); includes important information that is necessary to understanding topic; If you have a long introduction in your report then you will want to use a shortened and condensed version for your poster.

**Questions/Hypotheses:** for EXPERIMENTAL PROJECTS; Question is optional…it may be redundant depending on your hypotheses.

**Design Goal:** for ENGINEERING PROJECTS instead of question/hypotheses.

**Materials and Methods (Experimental Design):** If you have a long section in your report, then you may want to shorten this section for your poster.

**Results:** graphs, tables, data information; remember that each chart should be properly labeled with a descriptive title and axes labels (graphs); Each visual should have a short, descriptive caption with each table and figure numbered and these numbers should correspond to discussion about the data in the next section. The captions are important since they are the quickest way the judges can understand your project.

**Discussion:** discuss whether data support or refute the hypotheses; refer to figures (graphs and tables) to support the conclusions you draw. Include flaws in the experimental design. *This is one of the most important sections!* Again, because of space limitations this section may be condensed to fit on your poster.

**Conclusion:** A few sentences or bulleted statements that refer directly to your hypotheses.

**References:** APA format (minimum of 5) [http://citationmachine.net/](http://citationmachine.net/)

**Photos:** Must include “photo taken by _____” and any picture of a subject must not show his/her face. Each photo should also have a caption. You cannot show any surgical procedures.

**What to display with your poster**

1. Notebook (diary with comments, interpretations, experiments, experimental data, etc…)
2. Research Report in a binder or folder
3. Research Plan in a binder or folder
4. Testing materials: sample surveys or actual surveys (be sure there are no subject names) in binders or folders
5. Computer demos: include testing materials (psych projects) Include demonstrations of gaming materials, with quick access to the code
6. Engineering: Bring design items, prototypes
DISPLAY BOARD LAYOUT

Use the display below for general guidelines on how to organize research information.

**Other helpful hints**

**Title:** Make it catchy and descriptive. You can have a fun or short main title with a more descriptive sub-title underneath in smaller lettering.

**Theme & Colors:** Often it is best to choose only 2 or 3 colors for your entire poster. Maintain the same theme and fonts throughout the entire poster. Print graphs and pictures in color.

**Neatness & Organization:** Although the look of your poster doesn’t officially affect your score, it can subconsciously affect the way the judges feel about you and your project. Make sure lines are straight, everything is cut out nicely, and that the organization is easy to follow. Use “zots” or “adhesive mounting pads” for a 3D effect.

**Font:** Choose at least size 14 font so it can be read from a distance of 3 feet. Use a simple font like Times or Arial.

**Fitting it all in:** When printing out your sections, you can use the most narrow margins to fit more words on a page as long as it will fit in your poster. You can also choose to layer multiple graphs, tables, or testing materials by placing in sheet protectors, overlapping, and attaching with brad fasteners. Use this “flip chart” style only with related data, series of photos, or steps.
Pros:
1. Large, readable title
2. Data in center
3. Hypothesis and Introduction on left side
4. Materials, Methods & Conclusion on right side

Cons:
1. Color scheme not consistent
2. Layout at bottom of data is messy
3. Subtitle clippings not same size

Pros:
1. Large, readable title and section headings
2. Consistent color scheme
3. All text is on a colored background paper

Cons:
1. Font size too small on main texts
2. Picture at bottom seems like an afterthought
JUDGING TIPS

ORGANIZE

- Prepare a 2-3 minute speech that you can give at the beginning of each judging, if asked. Be prepared for judges to interrupt with questions. Don’t ignore a question! The speech is there to simply get the ball rolling if the judge asks, “So, tell me about your project!” Include:
  - Why this project? Why is it important/relevant?
  - Briefly, what you did in experimentation?
  - Important findings
  - Statistical Analysis (refer to visuals)
  - Your conclusion

- Come up with a list of potential questions the judges may ask you.
  - Why is this research important? Who cares?
  - What does your data tell you?
  - What do your graphs represent? Why did you choose to display it this way?
  - What kind of help did you receive from others?
  - What did you learn?
  - What problems did you encounter?
  - What follow-up research could you do?

- Know your background research. Be able to talk about what has already been done on the topic and why your project is different or relevant. Many of your judges will be experts in the field and will know about current research. Make sure you are up-to-date.

PRACTICE

- Explain your project to others whenever you get the chance and to a wide array of people.
  - Start with your prepared speech
  - Explain graphs and tables and potential questions

- Video yourself during practice so you can pinpoint any flaws.

- Practice explaining your project in simple terms, so that the general public can understand. Explain it to a child. Many times they ask some great questions!

BE PROFESSIONAL

- Make a good first impression by acknowledging the judge when they approach. Say hello and introduce yourself. Be sure you stand and make eye contact.

- Always be dressed nicely. Never wear jeans and t-shirts.

- Use your display board as a tool to explain portions of your answers. Point to pictures or graphs and tables as you discuss them, but don’t turn away from the judge to look for an answer on your board.

- Be positive and excited.

- Be confident. Avoid, “Um”, “I think” and “maybe”. Don’t mumble.

- It is okay to say, “I do not know.” Don’t try to make something up. If you don’t know the answer to a judge’s question, say so and move on.

- Take notes after each interview (if possible) or each fair, recording questions that may have stumped you. Also record the judges’ names and where they work. If there is an appropriate time at the end of the interview to ask if you might contact the judge, you can request an email address.

- After each fair, try to ask your judges for feedback to help improve your project. You may see your judge during the public open house or at the awards. You may also be able to track down an email from a work website.
INTERVIEW PRACTICE

Find 2 people with whom you can practice. FIRST, give your short 2-minute “speech.” SECOND, have them interview you for the next 3 minutes. Afterwards, ask your interviewer the following questions. Answer the questions on the back of this sheet.

INTERVIEW 1
What was good and what can I improve with my prepared speech?
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
What was the best part of the interview?
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
In what ways can I improve the interview?
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

INTERVIEW 2
What was good and what can I improve with my prepared speech?
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
What was the best part of the interview?
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
In what ways can I improve the interview?
___________________________________________________________________________
___________________________________________________________________________
1. What questions were asked often?

2. What information did I not know or didn’t know well enough? (Do additional research on these topics)

3. Which topics were not discussed that I wish would have been? (If you don’t think judges will get to these topics, consider adding a bit about them in your speech, to encourage questions about them)

4. What parts were hard for me to explain? (practice these parts)

Continue practicing with family and friends. The more comfortable you are discussing your project, the more confident you will feel on Science Fair day
May 1, 2013

Emilie Smith, Ph.D.
1234 S University Dr. #102
Salt Lake City, UT 84102

Dear Dr. Smith,

I want to sincerely thank you for the help you provided to me this past year. Access to your lab was crucial to the success of my science fair project.

This year, I qualified to attend the Salt Lake Valley Charter Schools Science & Engineering Fair, as well as the regional Salt Lake Valley Science & Engineering Fair at the University of Utah. I earned 2nd place at the charter schools fair in the Biology category and 1st place at the regional fair in the category of Microbiology.

I plan to continue my research on oleophilic bacteria and hope to advance to the International Science & Engineering Fair next year. I also plan to attend the University of Utah and hope to work more with you and your lab.

Thank you again for all your help and support in my endeavors.

Sincerely,

Tara L. Wion
Student Scientist
Academy for Math, Engineering & Science

(You may also want to include your research report if you think the person you are thanking would be interested. To do this type...)

Enclosed: The title of your report.
The portfolio will include reflection pieces at the beginning of each section, as well as an overall reflection piece. A reflection paper is about personal reactions and thoughts that the student has in regards to a particular area of work or learning.

**Category Reflections**

A short (1/2 - 1 page) reflection should be included at the beginning of section within the portfolio. This reflection is composed by the student and discusses the work he/she has included within that section alone. It should discuss what he/she learned, how he/she has improved in that area, and what he/she could improve upon. The student should refer to evidence within that section to discuss issues.

**Overall Reflection**

A major artifact in the portfolio should be a 2-4 page self-reflection piece that encompasses the student’s overall learning, improvement, and areas for improvement in the science fair process and life, in general. The student can discuss their reactions to the science fair process; what went well, how they can be more organized, what excited them, what was frustrating, etc. General reactions and thoughts about life can be discussed as well; perhaps considering career paths in science, internship possibilities, colleges that could support a given career path, necessary lifestyle changes in order to achieve those goals.
# Background Essay Rubric

**Student Name:** __________________________________________

<table>
<thead>
<tr>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td><strong>Topic</strong></td>
<td>It is not clear what the topic of the essay is.</td>
<td>Reader must guess what topic is based on loosely connected information.</td>
<td>Topic is vaguely established in paper.</td>
<td>Topic is well established within the paper, but it is not established in first paragraph</td>
<td>Topic is well established within the first paragraph</td>
</tr>
<tr>
<td><strong>Organization</strong></td>
<td>The essay is not organized. The paragraphs begin and end arbitrarily.</td>
<td>The essay has little organization.</td>
<td>The essay is fairly organized, but could use much improvement.</td>
<td>The essay is organized in a manner, but it can be improved with clearer paragraphs and/or more obvious beginning and end.</td>
<td>Paper is well organized. Each paragraph has a specific purpose. There is a clear beginning, middle, and end.</td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>The content of this essay is poor. There are no scientific facts to back up statements. The information may not be relevant to the topic.</td>
<td>There are very few facts to back up this essay.</td>
<td>There are some facts and content, but the essay need much more quality information to be successful.</td>
<td>The essay contains good information, but is missing important details that could improve the paper.</td>
<td>The essay includes important, quality information relevant to the topic. It includes stats and prior studies that relate and gives a sense of importance to the topic. Statements are backed up by scientific facts.</td>
</tr>
<tr>
<td><strong>Grammar, Spelling, and format</strong></td>
<td>There are many spelling and grammar mistakes. It is not in APA format and is not in 3rd person passive (it uses I, we, you, me, etc.)</td>
<td>There are some major spelling, grammar, AND formatting issues.</td>
<td>There are spelling, grammar, and/or formatting issues.</td>
<td>There are a few minor grammar, spelling issues and/or formatting issues (APA and 3rd person passive)</td>
<td>There are no grammar or spelling issues. The paper is written in APA format in 3rd person passive.</td>
</tr>
<tr>
<td><strong>References</strong></td>
<td>There are no references.</td>
<td>There are a couple of references, but they are not cited correctly in APA style.</td>
<td>There are at least 3 references and they are cited, but are not in proper APA format.</td>
<td>There are at least 4 references and they are in APA format with some few minor errors.</td>
<td>There are at least 5 references. They must be proper in-text citations and also included in the reference. APA format.</td>
</tr>
</tbody>
</table>

**Suggestions or Comments:**

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

**Score:** _________
### Materials & Methods Rubric

#### Student Name: ____________________________________________

<table>
<thead>
<tr>
<th>Question &amp; Hypotheses/Design Goal</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>The question &amp; Hypothesis OR design goal is not specific or testable. A new hypothesis or DG should be written</td>
<td>←-----------------</td>
<td>States Question &amp; Hypotheses OR Design goal, but it needs to be more specific</td>
<td>←-----------------</td>
<td>Essay states question and includes testable hypotheses OR Essay includes a specific Design Goal</td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td>Includes a very incomplete or very unspecific list of materials</td>
<td>←-----------------</td>
<td>Includes a list of materials, but it is partially incomplete and is missing some specifics</td>
<td>←-----------------</td>
<td>Includes a complete and specific list of materials</td>
</tr>
<tr>
<td>Organization</td>
<td>The essay is not organized. The paragraphs begin and end arbitrarily.</td>
<td>The essay has little organization.</td>
<td>The essay is fairly organized, but could use much improvement.</td>
<td>The essay is organized in a manner, but it can be improved with clearer paragraphs and/or more obvious beginning and end.</td>
<td>Paper is well organized. Each paragraph has a specific purpose. There is a clear beginning, middle, and end. It is in chronological order.</td>
</tr>
<tr>
<td>Content</td>
<td>The content of this essay is poor. There are no scientific facts to back up statements. It lacks very important details and is confusing.</td>
<td>There are very few facts to back up this essay. There needs to be much more detail on the plan. Many parts are confusing.</td>
<td>There are some facts and content, but the essay need much more quality information to be successful. Some parts lack detail or are confusing.</td>
<td>The essay contains good information, but is missing important details that could improve the paper. It could be improved with better details.</td>
<td>The essay includes important, quality information relevant to the topic. Statements are backed up by scientific facts. It is very detailed and could be duplicated by anyone.</td>
</tr>
<tr>
<td>Grammar, Spelling, and format</td>
<td>There are many spelling and grammar mistakes. It is not in APA format and is not in 3rd person passive (it uses I, we, you, me, etc.)</td>
<td>There are some major spelling, grammar, AND formatting issues.</td>
<td>There are spelling, grammar, and/or formatting issues.</td>
<td>There are a few minor grammar, spelling issues and/or formatting issues (APA and 3rd person passive)</td>
<td>There are no grammar or spelling issues. The paper is written in APA format in 3rd person passive.</td>
</tr>
</tbody>
</table>

#### Suggestions or Comments:

______________________________________________________________________________________

______________________________________________________________________________________

______________________________________________________________________________________

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______________________________________________________________________________________

Score: ____________
# Research Report

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</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td>The content of this essay is poor. There are no scientific facts to back up statements. The information may not be relevant to the topic.</td>
<td>There are very few facts to back up this essay.</td>
<td>There are some facts and content, but the essay need much more quality information to be successful.</td>
<td>The essay contains good information, but is missing important details that could improve the paper.</td>
<td>The essay includes important, quality information relevant to the topic. It includes stats and prior studies that relate and gives a sense of importance to the topic. Statements are backed up by scientific facts.</td>
</tr>
<tr>
<td><strong>Materials &amp; Methods</strong></td>
<td>Does not include materials or procedures.</td>
<td>Includes a list of materials and procedures but it is not detailed or has not been updated from the research plan.</td>
<td></td>
<td></td>
<td>Materials &amp; methods are present and updated to accurately portray student’s research. Must be in past tense.</td>
</tr>
<tr>
<td><strong>Organization</strong></td>
<td>The essay is not organized. The paragraphs begin and end arbitrarily.</td>
<td>The essay has little organization.</td>
<td>The essay is fairly organized, but could use much improvement.</td>
<td>The essay is organized in a manner, but it can be improved with clearer paragraphs and/or more obvious beginning and end.</td>
<td>Paper is well organized. Each paragraph has a specific purpose. There is a clear beginning, middle, and end. It is in chronological order.</td>
</tr>
<tr>
<td><strong>Data</strong></td>
<td>No data is displayed</td>
<td>Some data is present but not easily readable.</td>
<td></td>
<td>Relevant data is present and clearly displayed in readable tables and graphs. Captions and axis labels are present for each figure. Units of measure are indicated.</td>
<td></td>
</tr>
<tr>
<td><strong>Discussion &amp; Conclusion</strong></td>
<td>Little discussion of the data is present. No apparent conclusion has been formed.</td>
<td></td>
<td>Discussion of data is present but it is not fully interpreted. An incomplete conclusion is present.</td>
<td>The data is discussed and analyzed to determine whether or not the hypothesis is supported. A conclusion is formed based on the analysis.</td>
<td></td>
</tr>
<tr>
<td><strong>Grammar, Spelling, and format</strong></td>
<td>There are many spelling and grammar mistakes. It is not in APA format and is not in 3rd person passive (it uses I, we, you, me, etc.)</td>
<td>There are some major spelling, grammar, AND formatting issues.</td>
<td>There are spelling, grammar, and/or formatting issues.</td>
<td>There are a few minor grammar, spelling issues and/or formatting issues (APA and 3rd person passive)</td>
<td>There are no grammar or spelling issues. The paper is written in APA format in 3rd person passive.</td>
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**Suggestions or Comments:**

Score: _________
Oral Presentation Rubric

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
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</thead>
<tbody>
<tr>
<td><strong>Content</strong></td>
<td>Shows a full understanding of the topic.</td>
<td>Shows a good understanding of the topic.</td>
<td>Shows a good understanding of parts of the topic.</td>
<td>Does not seem to understand the topic very well.</td>
</tr>
<tr>
<td><strong>Comprehension</strong></td>
<td>Student is able to accurately answer almost all questions posed by classmates about the topic.</td>
<td>Student is able to accurately answer most questions posed by classmates about the topic.</td>
<td>Student is able to accurately answer a few questions posed by classmates about the topic.</td>
<td>Student is unable to accurately answer questions posed by classmates about the topic.</td>
</tr>
<tr>
<td><strong>Slide Appearance</strong></td>
<td>It is attractive and contains a few visuals &amp; diagrams. The text is easy to read from a distance</td>
<td>The slides have color and are easy to read. There are little to no graphics. Slides improve overall presentation.</td>
<td>Slides are plain, no graphics. Slides still improve overall presentation.</td>
<td>It is plain and/or very difficult to read. It has no graphics OR graphics detract from the presentation.</td>
</tr>
<tr>
<td><strong>Preparedness</strong></td>
<td>Student is completely prepared and has obviously rehearsed.</td>
<td>Student seems pretty prepared but might have needed a couple more rehearsals.</td>
<td>The student is somewhat prepared, but it is clear that rehearsal was lacking.</td>
<td>Student does not seem at all prepared to present.</td>
</tr>
<tr>
<td><strong>Speaks Clearly</strong></td>
<td>Speaks clearly and distinctly all (100-95%) the time, and mispronounces no words.</td>
<td>Speaks clearly and distinctly all (100-95%) the time, but mispronounces one word.</td>
<td>Speaks clearly and distinctly most (94-85%) of the time. Mispronounces no more than one word.</td>
<td>Often mumbles or cannot be understood OR mispronounces more than one word.</td>
</tr>
</tbody>
</table>

Suggestions or Comments:  

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

Score: _________
# Science Fair Progress Evaluation

Name:____________________________

Dates: ________--__________

What are my goals for this time period? Include due dates and be specific.

<table>
<thead>
<tr>
<th>Poor</th>
<th>unsatisfactory</th>
<th>satisfactory</th>
<th>excellent</th>
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</table>

(to be completed at the end of the time period)

Did I meet my Goals? What did I accomplish?

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<tr>
<th>Poor</th>
<th>unsatisfactory</th>
<th>satisfactory</th>
<th>excellent</th>
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**Self Evaluation**

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**Teacher Evaluation**

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</table>
Notebook Check

- Is it detailed?
- Is the format correct?
- Is it legible?
- Is it written in pen?
- Is it free of scribbles?
- Is it dated?

**Self Evaluation**

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**Teacher Evaluation**

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Project notes or concerns:

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# STEM Fair Planning

<table>
<thead>
<tr>
<th>Month</th>
<th>Theme</th>
<th>Weekly Goal</th>
<th>Notes</th>
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<tbody>
<tr>
<td>August</td>
<td>Ideas</td>
<td>1 Introduce Experimental vs. Engineering</td>
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<td>2 Brainstorm</td>
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<td>September</td>
<td>Ideas</td>
<td>1 Brainstorm and Research Methods</td>
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<td>2 Research Topics</td>
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<td>3 Question/Problem Synthesis</td>
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<td>4 Research and Write</td>
<td>Background Essay</td>
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<td>October</td>
<td>Plan</td>
<td>1 Hypothesis/Design Goal</td>
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<td>4 Write</td>
<td>Research Plan</td>
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<td>November</td>
<td>Do</td>
<td>1 Set-up/Collect Materials</td>
<td>Paperwork</td>
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<td>2 Carry-out design</td>
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<td>3 Collect Data</td>
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<td>4 Collect Data</td>
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<td>December</td>
<td>Analyze</td>
<td>1 Tables and Graphing</td>
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<td>2 Statistics</td>
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<td>3 Talk/Write about Data – What does it mean?</td>
<td>Data Analysis</td>
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<td>January</td>
<td>Wrap-Up</td>
<td>1 Conclude</td>
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<td>2 Write “Research Wrap-Up”</td>
<td>(Research Report)</td>
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<td>3 Discuss – Interview Skills</td>
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**Research Report** = Introduction (Background Essay) + Research Plan (change to past-tense) + Data + Data Analysis (discuss what you found and whether the data “supports” or “does not support” your hypothesis or design goal) + Conclusion (What does it all mean? What problems were there or changes you would make?)