**Science Research Project Introduction**

“Chemists are the people who transform the everyday materials around us into amazing things.”

<http://www.acs.org/content/acs/en/careers/whatchemistsdo/careers.html>

It is time for YOU to determine what you would like to learn about! What are you passionate about? What can you transform? Do ants keep getting in your dog food? How could you solve this problem? What is a problem in your everyday life that you could solve- annoying toothpaste container? How could you improve it? Is there something you use that could be used for something different? Last year a student took a pen that had 4 different colors in it (one pops up at a time) and put makeup brushes in it instead!

This year you will complete a science research project or an engineering design project. A huge part of this project is creativity of thoughts and ideas. You may complete a project using common substances we’ll be using in class, such as sand, cornstarch, sodium polyacrylate, acetylsalicylic acid (aspirin), or Nitinol. Or you may choose a science topic of your choice. Before any project can be started it must be approved and involve the quality and depth expected of a high level high school student. There will be a strong emphasis on your ability to discuss the project during your interview. Engineering projects are also being encouraged by the county.

The Step 1 form is to help you come up with an idea and find a topic – you should spend time on this form and jot down all ideas that you have on it. The last page of the Step 1 handout will have you submit an idea for a project. Remember – your job is to pick a topic that you are passionate about and that is complex enough for a high school student! Do not google – “science fair ideas” – you will get very basic project ideas. Instead, think about what YOU are interested in. The following are sites that could help you find an idea. (Most of these are in the Step 1 Assignment.)

|  |  |
| --- | --- |
| <http://www.sciencebuddies.org/> | Great site for ideas and to see what you are interested in – most topics are too simplistic and you would need to make them more complex; some surveys and procedures here might be helpful |
| [www.eurekalert.com](http://www.eurekalert.com)  <http://www.sciencedaily.com/> | Read over these Breaking News science articles and then search for topic that you are interested in. These are summaries of current research that is being done. Think about how you could adapt the article you are interested in to a project that is doable. |
| <https://www.youtube.com/results?search_query=science+nation&oq=science+nation&gs_l=youtube.3..0l3j0i5l4.402.2894.0.3367.13.8.0.0.0.0.342.1487.0j6j1j1.8.0...0.0...1ac.1.11.youtube.LOWO4p9cuhs> | Science Nation videos -2-3 minutes each – exciting topics –over 185 videos |
| <http://www.amnh.org/learn-teach/young-naturalist-awards/winning-essays2/2011-winning-essays/the-secret-of-the-fibonacci-sequence-in-trees> | Outdoor projects – Check out Aiden and how he made more efficient solar cells by studying the fibanocci sequence of tree branches |
| <http://www.societyforscience.org/isef/> | Official science fair website –has projects from previous years, rules, forms, etc…. Be sure to read rules if are interested in bacteria, animals, humans, hazardous chemicals, etc… |
| <http://www.pbs.org/wgbh/nova/sciencenow/> | Interesting science videos |
| Log into the student portal and look at online research resources. Go to [www.chhsmediacenter.com](http://www.chhsmediacenter.com), and choose research tab – science databases | Science Databases – you can access eurekalert and science daily here. Look through all of these – also notice science in context |
| <http://www.acs.org/content/acs/en/education/resources/highschool/chemmatters.html> | Chemistry articles |
| <http://pbskids.org/designsquad/>  <http://www.teachengineering.org/> | Neat engineering websites |
| ABC Nightline IDEO Shopping cart  <https://www.youtube.com/watch?v=M66ZU2PCIcM> | Great engineering motivational video on how to brainstorm and develop an engineering project |

Team:

**Science Research Team Checklist for Assignments**

|  |  |  |
| --- | --- | --- |
| **Assignment** | **Check off when turned in** | **Points** |
| **Step 1 Finding idea** WS pg 4-10 |  | 50 |
| **Step 2 Topic (1 per team)**   * Topic approved (pg 13) * Typed Literature Cited with at least 5 references |  | 25 |
| **Step 3 Research (1 per person)**   * Research notes |  | 75 |
| **Step 4** **Research Plan**   * Final typed with survey |  | 100 |
| **Step 5** **Forms** Circle the form when it is in folder | 1 1A 1B |  |
| **Step 6** **Background** – 2-5 typed pages in paper template |  | 100 |
| **Step 7** **Data**   * Data tables set up in logbook and title page * All data collected |  | 50 |
| **Step 8 Data Analysis**   * Raw data typed into excel spreadsheet * Data table, graph, t test |  | 50 |
| **Step 9 Discussion and Conclusion** |  | 100 |
| **Step 10 Abstract** |  | 50 |
| **Step 11 Paper/Log Book** |  | 100 |
| **Step 12 Display Board** |  | 200 |
| **Research Team Points** |  | 100 |

**Science Research Project Assignments**

1. Design an experiment (you are required to take pictures every step of the way unless you are doing a human survey project).
2. Do the experiment keeping up with data in a log book
3. Write a paper that includes all parts of the experiment (Title Page, Abstract, Background, Research Plan, Results – Data Tables, Graphs, T-Test Chart, Discussion and Conclusion, Literature Cited, Appendix with survey if applicable)
4. Create a Display Board showcasing the experiment

**Steps to Complete** (Step 1, Step 3 Research notes, Step 4 Form 1B –complete per person; all other steps – 1 per team)

* + **Step 1:** **Finding an Idea** Worksheet– see attached (7 pages)
  + **Step 2: Science Project Idea – Final Submission –**Pg 13 and Literature Cited
  + **Step 3: Research** Take notes on at least 5 resources on your topic which give background research and information to design your project.
  + **Step 4:** **Research Plan**  Procedures, etc… Survey must be included at this point for behavioral projects. (100 pts**)**
  + **Step 5: Science Fair Forms** - Most forms are included in the packet. A complete list of Science Fair Forms can be found at [**www.societyforscience.org/isef/**](http://www.societyforscience.org/isef/). You must turn in Forms 1, 1A, and 1B and any others pertaining to your project**.** Can’t complete project without these forms**!**
  + **Step 6** Write **Background** for project. (100 pts) The Background should be written in 3rd person, explain the background information about your topic and the reasoning behind your choice of study. Use parenthetical citations. No plagiarism. Minimum: 2 typed pages
  + **Step 7: Collect Data**. **-You must take pictures!**
    - Perform experiment and record data directly in log books (neatly, data tables, etc..)
  + **Step 8: Data Analysis**–see attached sample.
    - Raw data typed into excel spreadsheet
    - Data averaged in excel, data graphed (averages or all), t test chart completed
  + **Step 9** Write **Discussion**, and **Conclusion** for your paper. Final paper
  + **Step 10** Write **Abstract**–see attached instructions
  + **Step 11** Finalize **Log Book** and **Paper**
  + **Step 12 Display Board**

**Step : 1 Finding an idea (pages 4- 11)** Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Science Research allows you to deeply investigate a topic that you are interested in! You choose the topic –it is important that you pick a topic that you are interested in. As you do the activities below, reflect on which activities that you enjoy the most. If the answer is none, then talk to others who know you well and YOU come up with some ideas! This is your project –take ownership!

1. **Survey**

|  |  |  |  |
| --- | --- | --- | --- |
| A) Circle all of the topics that you are interested in. Add any others that you can think of! | Music Psychology Forensics Sports How people learn  Nature Math Games Nature Plants Engineering  Biology Chemistry Physics Environmental Science Behavior | | |
| B) Rate the following with:  1 very interested  2 somewhat interested  3 not really interested | 1. Using sodium polyacrylate (stuff in diapers) to make better sandbag barriers to decrease flooding. 2. Do nanoparticles that are in many current consumer products cause genetic changes in fruit flies? 3. How do friends and families influence interracial relationships? 4. Using cornstarch bumpers to reduce car damage. 5. Can bricks made from a composite of concrete and fruit peel powder absorb nitrates to prevent fertilizer runoff from contaminating streams? | | |
| C) The above projects were completed by CHHS students last year and went at least to county science fair! What do they have in common? How do they differ? | Similarities | | Differences |
| D) What is the difference between an engineering project and a science project? |  | | |
| E) Brainstorm possible engineering projects |  | | |
| F) Brainstorm possible science projects |  | | |
| G) Brainstorm possible psychology/learning projects |  | | |
| H) Rank the 3 types of projects based on your interest from 1-3 using the above rating scale | Behavioral (survey/psychology) Engineering Science | | |
| I) I will probably pursue a science/medical/engineering career? | Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree | | |
| J) Do you prefer to work alone or in a group of 2 or 3? *Alone is sometimes the preferred method if you are seeking a science career or a competitive project.* |  | | |
| K) Make a list of things you are curious about.  Think about your hobbies and interests. Identify questions that arise with them. List occupations of your family members and friends of the family. | |  | |

**How do students find a project idea? By thinking about what they are interested in, reading current research, talking to others, watching videos, etc…. You will now do a series of activities to help YOU find a research project. As you do these, the purpose is not to hurry up and do them but to take your time and reflect on how you could turn the ideas you like into your own unique project!**

1. Go to the attached websites and fill the boxes with possible ideas/thoughts about projects in general and about ideas that you might like more specifically. Your reflections of the activities should be thoughtful and complete. If questions or specific instructions are given, then follow them. Constantly be thinking about why these websites were chosen. Use additional paper as needed! This handout is on your teacher’s webpage. Each of these will take about 30 minutes (3-4 hours total) so do NOT procrastinate!

|  |  |  |
| --- | --- | --- |
| 1. <http://www.sciencebuddies.org/>  * Take the survey on the bottom right section labeled **Help Me Find a Project** and list at least 3 projects that it suggests for you. * Also, search through this website – most of the ideas are too simplistic but it is a good place to start. Students who have successfully used this website combined 2 ideas into one project and/or used the procedures given but used their own idea. * There are also some helpful surveys/tools here –example –a hearing test online, identifying a fake smile survey, etc… See if you can find a survey or test for something. For example, **type in behavioral surveys in the search box top right.** You try different things. * Remember to look for advanced projects or think about how you can make the project more advanced. Try clicking on Project Guide and then hitting Advanced project guide! | | 3 project ideas:                Other ways this website can help or ideas you found: |
| 1. <http://www.eurekalert.org/> Click on Breaking News and skim at least 10 articles (ignore all the cancer and space and stuff that is not doable)– jot down any ideas that you see for possible projects. Now click on one or more of the subjects and skim another 10 articles and jot down any ideas that you see. Everyday 40-50 new research articles are put here – so check each day! | | Read and jot ideas! |
| 1. <http://www.sciencedaily.com/> Skim through all categories and articles. Although many are the same as eurekalert, there are some different ones. Click on 10 that are of interest to you and describe them. Notice that if you click on one of these articles, it will give you several related articles as well! This can help you since you have to have a minimum of 5 references in your final project. Everyday 40-50 new research articles are put here – so check each day! | | Read and jot ideas! |
| 1. Watch any 3 of these Science Nation videos (2-3 min each) and describe what you saw and how they could be developed into a project. There are over 185 choices! <https://www.youtube.com/results?search_query=science+nation&oq=science+nation&gs_l=youtube.3..0l3j0i5l4.402.2894.0.3367.13.8.0.0.0.0.342.1487.0j6j1j1.8.0...0.0...1ac.1.11.youtube.LOWO4p9cuhs> | |  |
| 1. <https://student.societyforscience.org/intel-isef> Watch one of the videos and describe. Where will this year’s ISEF be? …. Be sure to read rules if are interested in bacteria, animals, humans, hazardous chemicals, etc… | |  |
| 1. <http://www.pbs.org/wgbh/nova/sciencenow/>   Watch and jot ideas! | |  |
| 1. <http://pbskids.org/designsquad/> Watch the bubble wrap episode: <http://pbskids.org/designsquad/video/bubble-wrap/> | |  |
| 1. <http://www.acs.org/content/acs/en/education/resources/highschool/chemmatters.html> Click on Videos. | Watch and jot ideas! | |
| 1. <http://www.teachengineering.org/> |  | |
| 1. <http://www.sciencebuddies.org/science-fair-projects/references.shtml> Need to know how to do something specific? List 3 things from here that might be helpful. |  | |

1. What type of project are you most interested in completing: Engineering, Science, Behavioral or Not sure (then check out all three)?

**OR**

**OR**

|  |  |  |
| --- | --- | --- |
| **Science-Scientific Process** | **Engineering** | **Behavioral** |
| * **Ask a Question** * **Do Background Research** * **Construct a Hypothesis** * **Test Your Hypothesis by Doing an Experiment (Independent and Dependent variables)** * **Analyze Your Data and Draw a Conclusion** * **Communicate Your Results**   **Refer to:** [**http://www.sciencebuddies.org/science-fair-projects/project\_scientific\_method.shtml**](http://www.sciencebuddies.org/science-fair-projects/project_scientific_method.shtml) | * **Define the Problem** * **Do Background Research** * **Specify Requirements** * **Brainstorm Solutions** * **Choose the Best Solution** * **Do Development Work** * **Build a Prototype** * **Test and collect data and Redesign and collect more data** * **Not always done in this order.**   **Refer to bubble wrap video, shopping cart, and** [**http://www.sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml**](http://www.sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml) | * **Follow the scientific process.** * **Involves working with humans which can be very difficult.** * **Often involves a survey** * **Find ways to quantify survey results**.   **Refer to this website and #4 below**  [**http://www.sciencebuddies.org/science-fair-projects/project\_ideas/Soc\_survey.shtml**](http://www.sciencebuddies.org/science-fair-projects/project_ideas/Soc_survey.shtml) |

1. <http://www.gifted.uconn.edu/siegle/research/instrument%20reliability%20and%20validity/likert.html>
2. If you do not remember then study these examples: <http://www.sciencebuddies.org/science-fair-projects/project_variables.shtml#examples> and review the terms at : <http://www.sciencebuddies.org/science-fair-projects/project_variables.shtml#whatarevariables> and watch <http://www.youtube.com/watch?v=l5wIPzv-_GM>

**Step 1 (continued)**

**Topic Selection – Study the chart below BEFORE you get too interested in a topic.**

|  |  |  |
| --- | --- | --- |
| **Science Projects** | **Engineering Projects** | **Behavioral Projects** |
| Your research notes should include:   * Explanation of topic * Extent of problem or why this is important or who this affects * Previous research on topic with specific data – give examples * Unresolved issues – things that are still not known about topic * Cost and/or materials needed/procedure discussed and where you will be getting your materials * Plant studies: If you are growing plants, then let me know ASAP (Flinn Scientific; Wards or Carollina)   About $13 for 100 seeds; checks to CHHS Science or exact cash. Need money and order by \_\_\_\_\_\_ You can probably get seeds cheaper at a store that sells bird seed.   * If you need me to order anything else for you, then let me know ASAP (Flinn Scientific; Wards or Carollina Biological are the companies we use and their catalogs are online. You need item,catalog # and price. Make checks payable to CHHS or have exact change when your teacher tells you the exact price. * Any project performed on animals must have vet approval – see me * See the ISEF website for anything that you are not sure of or ask me | A special note about Engineering projects – You may NOT just build a model (ex: pumping heart, robot, bridge, etc..) or find a procedure for building something. The idea is to build something that works in a unique, creative way.  Steps to building something better:  **\_\_\_** Research how it is made  \_\_\_ Research problems with current design  \_\_\_ Research novel/cheaper materials that could be substituted into the design  \_\_\_ Is it feasible to insert your novel/cheaper material into making a new product?  \_\_\_ Research how it is currently tested-because you will have to test it and collect data  \_\_\_ What data could you collect to see if your new design is an improvement? You must be able to collect data so that you can compare the data from your 1st prototype to the data from your 2nd prototype to see if it worked better.  Another idea: Find a new use for something that is thrown away (concrete, carpet). Refer to: [**http://www.sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml**](http://www.sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml) | Your research notes should include:   * Explanation of topic * Extent of problem or why this is important or who this affects * Previous research on topic with specific data – give examples * Unresolved issues – things that are still not known about topic * Who you will test and do you have easy access to these people; You may not do any medical tests on people or give them medicines * It is difficult to obtain approval to test elementary or middle school kids unless you have a family member who works in a school and it can still be difficult then * You may NOT ask students under 18 if they are depressed, their weight, IQ, and anything that is personal * Survey-how will you make this – see science buddies website NOW <http://www.sciencebuddies.org/science-fair-projects/project_ideas/Soc_survey.shtml> * Study how to make a Likert scale   <http://www.gifted.uconn.edu/siegle/research/instrument%20reliability%20and%20validity/likert.html>   * Generally you must have a minimum of 200 surveys given |

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**Step 1: Topic Approval Form**  Name(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Needs/Supplies - what do I need to know to do the experiment (procedure, how to collect quantitative data, cost, equipment, where to purchase)?

**Background Info** – what all do you need to know about the topic and what quantitative data will you be collecting and how will you do this?

**Your Initial Research** – What do your 2+ articles say that is important to the idea that you want to investigate? What experiments have already been done? (Attach both articles. Relevant parts of articles must be highlighted).

Attach abstract/article

Estimated Cost:

Central Idea - your Passion

Complete IV/DV OR include engineering goal!

IV:

DV:

Need(Goal):

Design Criteria:

Hook/ Importance to the world - why do we care?

**Step 2: Final Topic and Literature Cited Instructions (pgs. 12-13)**

**Checklist:**

\_\_\_\_ I am passionate about this topic and/or I am interested in this topic.

\_\_\_\_ This is a topic that I can pursue that is worthy of the intellect of a Honors Chemistry student! (You will be presenting your research to other students and adults!)

\_\_\_\_ I have done enough research on this topic to know:

\_\_\_\_\_ the rationale for why this project needs to be done

\_\_\_\_\_ at least one similar study that has been done, who did it, and what they found out

\_\_\_\_\_ I can afford to conduct this experiment or build the prototype

\_\_\_\_\_ I have the equipment, knowledge, and resources to carry out this experiment

\_\_\_\_\_ I know what parts of this topic are unknown or questioned by experts in the field

\_\_\_\_\_ The answer is not known for sure by others – there is at least one aspect of this project that is unique to my project and unlike other experiments or protoypes!

\_\_\_\_\_ I have thought about how many trials would be feasible (the most possible-affordable, time ok,etc)

\_\_\_\_ I have decided to work by myself or with a group of 2 or 3. I know that if I go to Symposium that only 1 person in a team can go. If I work in a group, I pledge to do my share of the work and to communicate with my partners on a regular basis.

**Typed Literature Cited**

* You must have at least 5 references per person. One reference (your major one) should be shared by all team members but each team member must have 4 DIFFERENT references!
* Your team’s references should be typed in ABC order in MLA format (minimum of 5 references for a 1 person team; 9 references for a 2 person team; 13 references for a 3 person team). Use CHHS Media Center Research Page, Green Sample MLA Citation handout, and Easybib.com for help with MLA (sites like sciencedaily.com actually list the citation on the article – check the option for MLA format). Type your Literature Cited directly into the Paper Template (download from teacher website and save on flashdrive – you will use this for your entire project).
* Sample Literature Cited entry: account

“Cracking Cellulose: A Step into the Biofuels Future.” EurekAlert. AAAS, 2011. Web. 31 August 2011.

**Step 2 Science Project Idea – Final Submission**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_

(I would consider having a partner, but don’t have one at this time. )

***Complete section for only ONE project type (Experiment OR Engineering). Attach related, highlighted articles.***

Project Type:  **Experiment**

1. Problem/Question to be studied : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Variables

Independent: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dependent: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How will you measure the dependent?: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Importance – Why do we care? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Project Type: **Engineering**

1. Need/Goal (What are you building?): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Why would you do this? What are you trying to improve? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Design Criteria (What would you want your design to have?) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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4. When you build your prototype (1st design), what will you measure? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Step 4 Research Plan**

Your topic has now been approved but before you start your experiment, you must have an approved procedure which will be included in your Research Plan. At CHHS, we follow the ISEF rules for experimentation. The complete rule book is at <https://student.societyforscience.org/intel-isef>. There are very strict rules for working with animals, people, and hazardous chemicals and biological specimens. Please Type up your Research Plan into your saved Paper Template and include the following:

* 1. Rationale – 2-3 sentences stating what you are going to do, why, what is the scientific and/or societal benefit, and refer to at least one research study or article that you have researched that helps support the need for your project.
  2. 1) Hypothesis, Independent Variable, Dependent Variable, # of trials, Control Group

OR

Experimental Goal, Design Criteria, Prototype Design, How you will test the prototype

2) What are your expected outcomes?

* 1. 1) Detailed Procedure (Step by step);

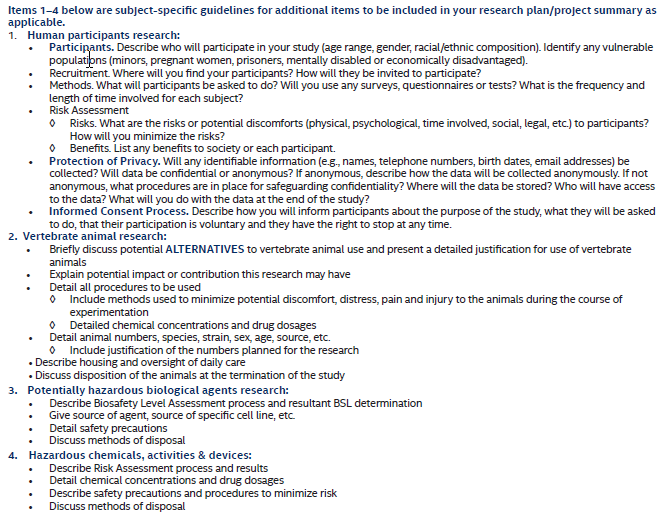
2) Safety and Concerns (Identify any potential safety concerns);

3) How you will analyze your data (For example, you will compare the amount of milk consumed by males versus females, different ethnic groups, and athletes vs. nonathletes).

4) Survey must be included if you plan to use one-see above websites

5) Lyrics to music, videos clips, pictures, tests, etc… must be included if you plan to use them

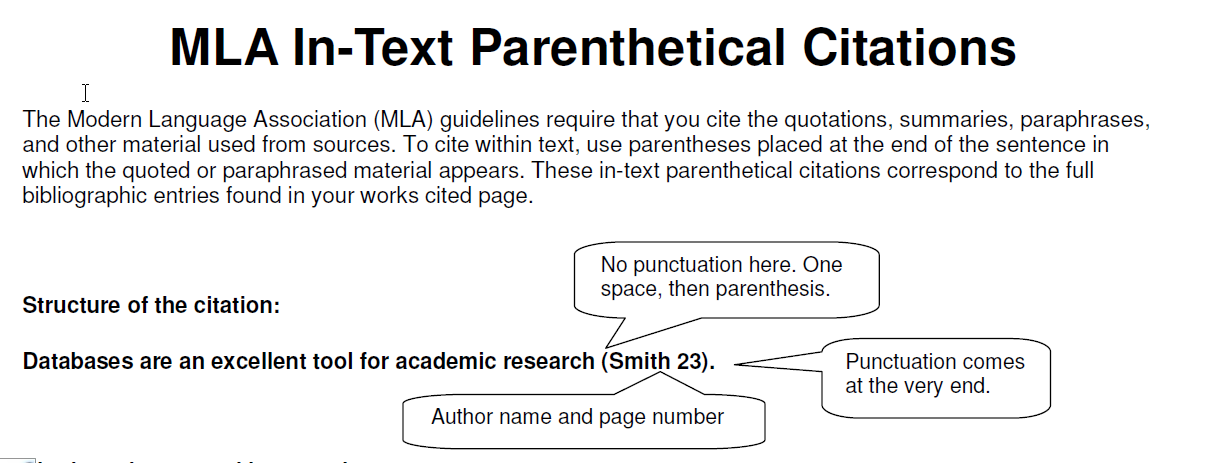
In addition, you must answer these questions if you project includes humans, animals, or hazardous chemicals or biological materials.



When the teacher has approved it, make any changes in your typed version and put a copy in your folder.

**Step 5 Science Fair Official Forms**

* Form 1 and 1A: 1 per team (forms will be provided in class)
* Form 1B: 1 per person (form will be provided in class) **will need a parent signature**
* Any additional forms required for your project can be found at [www.societyforscience.org/isef/](http://www.societyforscience.org/isef/)
* Supply Order forms: 1 per team if needed (anything you need to purchase through the school)

**Step 6 Background – You will turn in your Title Page, Background (2-5 pages), and Literature Cited pages (1 per team)**You have already saved your Research Plan and Literature Cited onto your Paper Template on your flashdrive. Now type Title page(see paper template-title must be less than 65 characters) and Background for paper. The Background, written in 3rd person, explains the background information about your topic and the reasoning behind your choice of study. Refer to previous research/ experimentation done on your problem. Include data from previous studies! Make sure all background information relates specifically to your problem and is significant to the understanding of the problem. Parenthetical references are to be used throughout the paper and a literature cited should be included at the end of the paper. (Make sure you use MLA format.) No plagiarism! You must have a parenthetical citation for most of the references that you found if not all. This paper must establish a strong rationale for the study by emphasizing unresolved issues or questions (i.e. why this experiment needs to be done). Conclude by stating the research hypothesis (this should be in the last paragraph of your Background -possibly the last sentence). Get teacher to approve. Minimum: 2 typed pages

Additional notes on parenthetical citations:

1. If there are no page numbers from a source, then just use the author’s last name.
2. If there are 2 authors, then (Smith and Jones 23). If there are 3 or more authors, then (Smith et al. 23)
3. If your source does not have an author, then just use the first word (not counting a, an, or the) which is in the Literature Cited citation.

For example, if you summarize information from this article:

“Soft Drinks and Tooth Decay” Pediatrics for Parents. Nov 11 2004:1-1.

Student Resource Center Gold. Thomson Gale. 21.11 Gwinnett County Public Schools, 13 September 2007 <http://findgalegroup.com/srcx/infomark.do?>

**Then you would cite it in your paper like this:**

Carbonated beverages have been shown to contribute to tooth decay because of the high sugar content in the drinks (Soft 1).

**Step 6: Background (continued)**

**In your paper be sure to:**

* Write in 3rd person (avoid I, me, my, we, our, you, your).
* Make sure your writing flows – did you transition from one paragraph to the next?
* Use spell check and have someone proofread your paper.

\_\_ Include title page (go to <http://www.societyforscience.org/isef/project_categories> to find out what category your project fits in). Your title should be formal (ex: The Effects of \_ on \_) and not cutesy.

* Include your Literature Cited in MLA style (5 sources for 1 person team; 9 sources for a 2 person team; 13 sources for a 3 person team)?
* Did you include parenthetical citations (you should have at least 1 citation for each source unless that source is about your procedure, buying materials, a survey, etc…)?
* Was your Background long enough (2-5 pages – if you are in a group, you should all write it together, and it should be longer than 2 pages since you have more information)?
* Avoid slang and “text” talk – this is a formal paper and should not sound like a conversation
* Time New Roman, **12 point font – 1 inch margins, double spaced**.
* Save as a new page in the same Word document you used for your Research Plan – we are building your paper! However, only print out the title page, Background, Literature Cited

**CHECKLIST - Writing the Background**

The CHECKLIST BELOW IS ONLY A GUIDE! dO NOT WRITE YOUR PAPER AS IF YOU WERE ANSWERING THESE QUESTIONS! Study the sample Red Bull Paper Intro also.

**Intro paragraph:**

* Starts with a hook – why is this topic important and why do we care about the topic?
* Outline briefly the main points about your topic so you can set up your paper.
* Why did you choose this topic? (Not: I chose this topic because… Instead: Determining if nanoparticles are harmful to the environment is important to research before nanoparticles are used for daily activities.)

**Body paragraphs should include:**

**Background information**

* Explain topic
* Describe what it is?
* Important terms
* How does it work?
* Discuss thoroughly all aspects (what it is, how to measure, the science behind the measuring, how it can be interpreted) of your independent variable and dependent variable
* DO NOT include a detailed step-by-step procedure
* Why is it important to people (if you have more to say than in the intro paragraph)?
* Include simple diagrams if applicable (not too memory intensive)

**Previous Research**

* Discuss in detail previous experiments WITH their data that relate to your topic.
* Avoid quotes – put in your own words!
* Don’t just say there was an increase, say it increased by 45%.
* Include 3-5 pieces of data (numbers)
* Cite research: There were 18 out of 55 cases of memory lapses (Brown 4). (1st word of bib. Entry page #)
* What are the researchers still trying to find out (**Unresolved Issues**)? Or what are people still wondering/arguing about?

**Concluding paragraph:**

* Pull together background information, previous research, and unresolved issues to make your hypothesis. Last sentence is your hypothesis.
* If ……(variation of independent variable), then ………….. (measurement of dependent variable).

**Step 7 Data Collection:** When approved, perform experiment safely and record data directly in to log books (neatly, data tables, all data including observations and reflections, etc…) Data must go directly into logbook – not on scrap paper, etc… Think about your data tables BEFORE you start experimenting-it is imperative to enter your data like shown below! Take pictures showing the progression of your experiment!

Log Book – 1 per project: Only needs to contain:

* Title page (title, teacher’s name, student’s name) – this information on the front cover also.
* Research Plan (2-3 sentence Rationale about why you are doing this experiment; hypothesis or engineering goal, independent variable/dependent variable or design criteria and prototype sketch)
* All data neatly recorded in charts

**Sample Data Tables**

1. **All data** must be entered into your research log book in neat data tables in pen and using metric measurements.
2. Everyone must have photographs of project for display board. If you do it at home, then you need lots of photos. No human faces in photos. If doing human survey project, not required.
3. You may have one huge data table or several smaller ones. Hints: Use numbers to represent words or letters. For example, use 1 for male and 2 for female. Do NOT enter units, %, times (3:02), etc… into spreadsheet.
4. If you have more columns than will fit on one page, it is okay to go to the next page and even more pages after that! The more data that you have, the more that you will be able to discuss your project.

**Sample: Human Survey**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Participants | Gender | Ethnicity | Pretest Score | Q 1 | Q2 | Post test | Q1 | Q2 |
| 1 |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |

**Sample: Plants** -You can have multiple data tables for your different groups

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Height of Control Group Plants | | | | | | | |
| Plants | Groups  A-Control  B-w/med | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 | Day 8 |
| 1 | A |  |  |  |  |  |  |  |  |
| 2 | A |  |  |  |  |  |  |  |  |
| 3 | A |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Observations of Control Group Plants | | | | | | | |
| Plants | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 | Day 8 |
| 1 |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |

**Sample: Engineering**- Performance of Prototypes 1 and 2

|  |  |  |
| --- | --- | --- |
|  | **Distance Prototype 1 Traveled (cm)** | **Distance Prototype 2 Traveled (cm)** |
| **Trial 1** |  |  |
| **Trial 2** |  |  |

**Step 8 Data Analysis (Pgs. 18-20) (1 per team)**(see sample) – The purpose of this section is to compare the results of your different groups. You will find the average of each group, create a data table, graph, and t-test chart to statistically compare your data. Which group performed better? You will turn in your Data Analysis page.

* Raw data typed into excel spreadsheet (as explained in Step 7)
* Data Table (s)
* Graph
* t-test chart

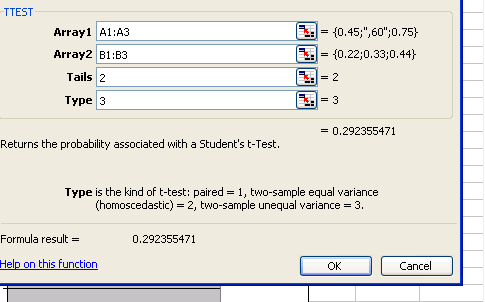
**Part A: Preparing your Data Analysis page**. Now all of your raw data is in your log book. You can use Excel to make data tables and graphs, and to statistically analyze your data.

1. Type in all relevant data (not just averages) into an Excel spreadsheet. See your teacher if you need help determining just what to type in-use guidelines given for setting up data tables in log book. If you don’t have all your data, you can still set up your excel data tables. Remember that it is easier to compare a column with a column for the t test. Do not put units or % in the excel data boxes. Just put the numbers.
2. You can make a chart in Excel with your average data. The average data is what goes in your paper and on your display board if you have lots of data. However if you do not have much data, then put all of the data in your paper/display board.
3. You can also make graphs in Excel (Insert, column, line, etc…). Play around with this to figure out the best graph for your data. Generally a bar graph is for comparison and a line graph for data collected over time. See example below.
4. Find the average of your data. First create a separate data table for averages.
   1. Click on the cell in your average data table where you want the average to go.
   2. Go to formulas, insert function, average. Enter array by entering the cell letter and cell #:cell letter and cell #. For example: A5:A7 This means that you want an average taken from all the data in A5 to A7.
   3. Hit ok.
5. Find the t test for your data. This will help explain your data-see below.
6. Create a chart with your t test data. It should look like this if you have 3 groups (control and 2 groups that you are testing-of course on your chart you will put what group 1 is, etc…), only put in bold for columns:

|  |  |  |
| --- | --- | --- |
|  | ***t* test (p value)** | **Statistically Significant?** (yes or no) yes if null hypothesis is rejected |
| Comparison between control and group 1 |  |  |
| Conparison between control and group 2 |  |  |
| Comparison between group 1 and 2 |  |  |

* 1. Click the cell under t test in the chart above where you want your p value to appear.
  2. Go to formulas insert function, choose category-statistics, scroll down to ttest, ok, enter array 1 by entering the cell letter and cell #:cell letter and cell # for the first column of data. For array 2 enter the cell letter and cell #:cell letter and cell # for the second column of data.
  3. For Tails enter 2
  4. For type enter 3
  5. Hit ok.

**Step 8: Data Analysis (continued)**



The t test value is .292355471. What does this number mean? Let’s see. Since it is greater than .05, there is no difference between the 2 groups you are comparing.

|  |  |  |
| --- | --- | --- |
| **p value** | **Null hypothesis –opposite of hypothesis** | **Statistically significant** |
| .05 or less | Reject | The data is statistically significant which means that there is a statistical difference between the 2 groups you are comparing. |
| Greater than .05 | Accept | The data is NOT statistically significant which means that there is NOT a statistical difference between the 2 groups you are comparing. At this point you can suggest repeating the experiment and using more trials, etc… especially if the p value is only slightly higher than .05 (.0501-.10) |

**Step 8 (continued) Sample Data Analysis Page**

|  |  |  |
| --- | --- | --- |
| **Stressed Plants (cm)** | **Nonstressed Plants (cm)** | **Destressed Plants (cm)** |
| 55 | 48 | 34 |
| 65 | 65 | 35 |
| 50 | 59 | 55 |
| 57 | 57 | 57 |
| 59 | 51 | 41 |
| 73 | 63 | 25 |
| 57 | 65 | 34 |
| 54 | 58 | 38 |
| 62 | 44 | 34 |
| 68 | 50 | 45 |

**Data Table of Averages**

|  |  |  |
| --- | --- | --- |
| **Stressed Plants (cm)** | **Nonstressed Plants (cm)** | **Destressed Plants (cm)** |
| 60 | 56 | 39.8 |

**Graph**

**t- Test Results**

|  |  |  |
| --- | --- | --- |
|  | **t-test (p value)** | **Statistically significant** |
| Comparison between stressed & nonstressed | 0.23 | No, greater than .05 |
| Comparison between stressed & destressed | 8.10E-05 | Yes, 000081 is less than .05 |
| Comparison between nonstressed & destressed | 0.00076 | Yes, .00076 is less than .05 |

**Step 9 Discussion and Conclusion (1 per team)**

* This is the heart of your paper! This is where you pull together your Background and Data Analysis to discuss the outcome and your interpretations of the outcome! Type this into the Paper Template (you already have the Title Page, Background, Research Plan, and Literature Cited pages completed)!
* Type 1-2 pages summarizing your findings and relating to the original research in your Background. Write your best work here. Use 3rd person.
* **Discussion**

\_\_\_\_\_Interpret statistical analysis

\_\_\_\_\_Restate hypothesis

\_\_\_\_\_Was hypothesis supported by research?

\_\_\_\_\_Significant? (p<.05)

\_\_\_\_\_Discussion of errors or problems

\_\_\_\_\_How did they affect results

\_\_\_\_\_How could experiment be changed to eliminate errors/problems

\_\_\_\_\_Compare results with what is already known about research question from your Background

\_\_\_\_\_Theoretical values

\_\_\_\_\_Published data

\_\_\_\_\_Commonly held beliefs/expected results

* **Conclusion – this will be the last paragraph of the discussion**

\_\_\_\_\_Draw conclusions about findings

\_\_\_\_\_What does all of this mean? (Possibly, “in light of the fact that the hypothesis

was/was not supported . . .”)

\_\_\_\_\_ Discuss possible applications that your findings could support or point to

\_\_\_\_\_Further experiments or extensions

**Step 10 Abstract: How to write one (Pgs. 22-23) (1 per team)**

The abstract is a concise summary of the entire research project. The abstract needs to be especially good since often judges form first opinions from the abstract. The following elements should be included in a proper abstract:

* Title (65 characters or less including spaces)
* Problem (what specific questions are addressed in the study, variables and limitations are identified, intent and objectives of the research effort are made explicit in this statement)
* Purpose (states the usefulness of the study-answers the question why the project was undertaken)
* Hypothesis (limits the scope of the investigation and unifies the research design, often is a If/Then statement)
* Procedure (brief summary of what was done)
* Conclusions (concise statement of the outcomes of the investigation, relate directly to hypothesis, identify unsolved aspects of the original problem or any new problems identified). Include average data and p-values from t-test.
* Rules for Abstract: Must be 12 point font, single spaced, typed on the Official GSEF Abstract Form found on web site, is limited to the square on the form, does not include cover sheets, graphics, etc…, and must be 250 words or less (200 or less for Symposium). Need 2 copies.

Hints: Use past tense and third person. Use correct spelling and sentence structure. Try to avoid use of *highly* specialized words or abbreviations. Restrict procedure to identification of method or type of process employed. State results, conclusions, or findings in clear, concise fashion. The abstract should be one continuous paragraph.

**Let’s write an abstract: The Effect of Multiple Washings of Silver Nano Socks on Bacteria**

**Sentences 1-2:** What made you choose this idea? Silver has been used as an antimicrobial agent since Roman Times. A 2006 research study by John Dolver shows how nanosilver particles in socks reduce odor-causing bacteria. (NOT – “I chose my project because I find silver and smelly socks interesting.”)

**Sentence 3-4:** Now you have a lead in for your purpose: However, there is concern that nanosilver particles will leach into the washing machine water and kill valuable bacteria used in water reclamation centers. This experiment examines the wash water’s effect on water reclamation bacteria.

**Sentence 5:** Here comes the hypothesis: If wash water from nanosilver (cotton-poly blend), cotton, and polyester socks are placed on (italicized bacteria name), the zone of inhibition will be lower in the nanosilver sock water, due to leaching of nanosilver particles in water.

**Sentence 6**: This leads into the procedure: The 3 socks were washed separately in 500 mL of water and constantly agitated. Each sock was washed 3 times and wash water was saved. Each water was put on a sterilized agar plate with bacteria and sealed.

**Sentence 7**: Gee, this is exciting – what happened? Here are your results: The cotton and polyester wash water plates showed a 0mm zone of inhibition as the bacteria grew all over the plate. The nanosilver wash water showed a 1.2mm, 0.8mm, and 0.8mm zone for the 1st, 2nd and 3rd washings.

**Sentence 8**: Is this statistically significant? The p-value from a *t* test between the cotton and polyester washings is 0.13 which shows no statistical significance, but between the cotton and nanosilver and between the polyester and nanosilver, a p-value of .042 and .034 respectively shows that there is statistical significant difference in these washings.

**Sentence 9**: What does this mean? Let’s wrap up the conclusion and go to lunch! The null hypothesis is rejected. The data supports the idea that a loss of silver nanoparticles in wash water affects water reclamation centers and therefore the environment.

**Step 10 Abstract (continued)**

**Sample Paper: Abstract**

**The Effect of Multiple Washings of Silver Nano Socks on Bacteria**

Silver has been used as an antimicrobial agent since Roman Times. A 2006 research study by John Dolver showed how nanosilver particles in socks reduce odor-causing bacteria. However, there is concern that nanosilver particles will leach into the washing machine water and kill valuable bacteria used in water reclamation centers. This experiment examined the wash water’s effect on water reclamation bacteria. If wash water from nanosilver (cotton-poly blend), cotton, and polyester socks is placed on (italicized bacteria name), the zone of inhibition will be lower in the nanosilver sock water, due to leaching of nanosilver particles in water. The 3 socks were washed separately in 500 mL of water and constantly agitated. Each sock was washed 3 times and wash water was saved. Each water was put on a sterilized agar plate with bacteria and sealed. The cotton and polyester wash water plates showed a 0mm zone of inhibition as the bacteria grew all over the plate. The nanosilver wash water showed a 1.2mm, 0.8mm, and 0.8mm zone for the 1st, 2nd and 3rd washings. The p-value from a *t* test between the cotton and polyester washings was 0.13 which showed no statistical significance, but between the cotton and nanosilver and between the polyester and nanosilver, a p-value of .042 and .034 respectively showed that there was statistical significant difference in these washings. The null hypothesis was rejected. The data supported the idea that a loss of silver nanoparticles in wash water affects water reclamation centers and therefore the environment.

**You have now written your abstract. Let someone else read it and make sure that it makes sense. Now count the words and make sure the title has 65 words or less and that the abstract paragraph has 250 words or less.**

1. Add this in to the electronic copy of your science fair paper.
2. Now copy your abstract and paste it into the Official ISEF abstract form found at

<http://www.societyforscience.org/isef/document> Scroll down to bottom and open Abstract form.

* In top box: Type title, your first name, middle initial and last name (teams include all names); and your school’s name, city and state
* In second box, cut and paste abstract (without title)
* Choose category and answer questions 1-6 (2 and 6 are yes; 3,4,5 are no)
* Print 3 copies but ONLY PRINT PAGE 1 – put one copy with Official Forms, one with paper, and one for the table in front of your display board

**Step 11 Finalize paper and log book (1 per project)**

\_\_\_ Entire paper is on Paper Template (1 document)

\_\_\_ Proofread paper – anything that is in red in the Paper Template should be deleted; all corrections to procedure, etc…. should be made

\_\_\_ Print out paper at home or in Media Center (check with them on cost)

**\_\_\_\_\_ Cover (title) Page** (start numbering on this page – in footer)

**\_\_\_\_\_ Paper Abstract** not on official form - put Title and Category at top

**\_\_\_\_\_ Background**

**\_\_\_\_\_ Research Plan**

# \_\_\_\_\_ Data Analysis

# \_\_\_\_\_ Discussion and Conclusion

\_\_\_\_\_Interpret statistical analysis

\_\_\_\_\_Restate hypothesis

\_\_\_\_\_Was hypothesis supported by research?

\_\_\_\_\_Significant? (p<.05)

\_\_\_\_\_Discussion of errors or problems

\_\_\_\_\_How did they affect results

\_\_\_\_\_How could experiment be changed to eliminate errors/problems

\_\_\_\_\_Compare results with what is already known about research question

\_\_\_\_\_Theoretical values

\_\_\_\_\_Published data

\_\_\_\_\_Commonly held beliefs/expected results

# \_\_\_\_\_Conclusion-last paragraph

\_\_\_\_\_Draw conclusions about findings

\_\_\_\_\_What does all of this mean? (Possibly, “in light of the fact that the hypothesis

was/was not supported . . .”)

\_\_\_\_\_ Discuss possible applications that your findings could support or point to

\_\_\_\_\_Further experiments or extensions

\_\_\_\_\_ **Literature Cited**

\_\_\_\_\_ **Appendix (if needed)-survey must be included here if you used one; sketch of prototype could go here**

**Log Book** – 1 per project: Only needs to contain:

* Title page (title, teacher’s name, student’s name) – this information on the front cover also.
* Research Plan (2-3 sentence Rationale about why you are doing this experiment; hypothesis or engineering goal, independent variable/dependent variable or design criteria and prototype sketch)
* All data neatly recorded in charts

**Step 12 Complete Display Board (1 per project)** Now is the time to display all of your hard work. Others will examine your work! The hard part has been done. It will take 2-3 hours to print everything out and glue on your board. Your display board should tell your story – you want to present to your audience the creativity and wonderfulness of your idea (to do this be sure to use research in your purpose ex: According to Smith (2008) blah blah blah….), display your data with pride and masterfully – it should look like you collected a ton of data and organized the findings well, and bullet the major points of your discussion and conclusion-these should logically progress. Market your results well!

(max 30” x 48” x 108”) –must stand on table

Suggested format:

\* Put your name, teacher name & school on back of middle at top

## Discussion

(bullet main points)

**Application to World**

## Conclusion

## Conclusion Statement(s)

(bulleted)

**Abstract** (optional)

# Title

* **Experiment at a glance-Chart with IV, exp groups, DV, #trials, controls, etc**
* **Pictures** with captions OR Survey if applicable
* **Data Tables** (include averages!)
* **Graphs**
* **Statistical Analysis**

## Purpose

Where did you get your idea –article? Step 3 Part A

**Hypothesis** (If, then statement)

Procedure

**Materials** (bulleted)

**Procedure** (bulleted)

## Helpful Hints

* Include photographs of important parts/phases of experiment (subjects abiding by safety standards) –All photos must be cited. No humans in your picture except yourself. Goggles!
* Be organized – should be logically presented and easy to read
* Make it Eye Catching and Professional – use neat headings, colorful matting, use contrasting colors
* Use the largest font possible and still have everything fit on your backboard
* Pay special attention to the labeling of graphs, charts, diagrams, tables, & photographs.
* Your board should tell your complete research “story” at a glance
* You must be prepared to answer questions about your project.