Honors Biology-Research Project: Wisconsin Fast Plants

Targeted *Standard Course of Study* Goals and Objectives:

5.01	Investigate and analyze the interrelationships among organisms, populations, communities and ecosystems • Techniques of field ecology • Abiotic and biotic factors • Carrying capacity
4.04	Analyze and explain the interactive role of internal and external factors in health and disease: • Genetics. • Immune response. • Nutrition. • Parasites. • Toxins.
1.00	Learner will develop abilities necessary to do and understand scientific inquiry. Goal 1 addresses scientific investigation. These objectives are an integral part of each of the other goals. Students must be given the opportunity to design and conduct their own investigations in a safe laboratory. The students should use questions and models to formulate the relationship identified in their investigations and then report and share those findings with others.
1.01	Identify biological problems and questions that can be answered through scientific investigations.
1.02	Design and conduct scientific investigations to answer biological questions. • Create testable hypotheses. • Identify variables. • Use a control or comparison group when appropriate. • Select and use appropriate measurement tools. • Collect and record data. • Organize data into charts and graphs. • Analyze and interpret data. • Communicate findings
1.03	Formulate and revise scientific explanations and models of biological phenomena using logic and evidence to: • Explain observations. • Make inferences and predictions. • Explain the relationship between evidence and explanation.

1.04	Apply safety procedures in the laboratory and in field studies: • Recognize and avoid potential hazards. • Safely manipulate materials and equipment needed for scientific investigations.
1.05	Analyze reports of scientific investigations from an informed scientifically literate viewpoint including considerations of: • Appropriate sample. • Adequacy of experimental controls. • Replication of findings. Alternative interpretations of the data.

Essential Questions:

How does a scientist design and perform an inquiry-based scientific investigation considering controls, variables, and data analysis?

What is the relationship between an independent variable and a dependent variable?

What is the importance of having a control in a scientific investigation?

How do you distinguish between an observation and an inference?

What are some potential hazards that can occur in a lab?

What is the difference between quantitative and qualitative data? When would you use one over another?

Introduction:

This research project was developed with several objectives in mind. As a scientist you question things that are going on around you and the best way to get an answer is to design and conduct an experiment. You also need to develop and practice your skills of observation, analysis and communication. This project will provide the opportunity for you to practice what a scientist does on the job. Your experience with research will help you in your other high school and college lab classes.

Deadlines:
This assignment is ***not*** to be completed in one evening. In order to do a good job with this assignment you will need to start early and not procrastinate. Think of this as an English term paper that is combined with a Biology lab activity. You need to complete sufficient background research before you can design your experiment. Then you need to set aside enough time to conduct your experiment ***at least*** one time. As you are designing your project schedule be realistic with your previous time commitments. After your experiment is finished you then need time to analyze your results so that you can communicate your findings and conclusions.

Basic outline of your Biology Research Project:

1. Topic selection & approval

2. Identify & confirm components that need to be researched
3. Thoroughly research the above components & use the information to make a hypothesis.
4. Completion of a typed Introduction Paper.
5. Designing your experiment.
6. Performing the experiment.
7. Recording & summarizing all data (charts, data tables, graphs, daily journal, photographs, etc.)
8. Analysis of data and conclusion.
9. Completion of Final Research Paper.
10. Presentation of research and experimental results at the science symposium (the date will be announced as soon as possible).

Below is a tentative list of deadlines (which are subject to change at the teacher's discretion):

- **(Week 1)** Topic / Question to be answered must be turned in and APPROVED!

- **(End of Week 1)** Identify/confirm components to be researched (Organism, Independent Variable & Dependent Variable).

- **(Week 2)** Experimental Design Due (materials & methods and sample data tables, graphs & charts)

- **(Week 7)** Rough Draft of your final research paper is due.
  - This paper will be the result of combining your: Introduction Paper + Experimental Design + Results. You should include actual data, tables, graphs, charts & pictures that will be in your final paper.
  - A new and VERY IMPORTANT component that must be included is the Analysis of your data and the final conclusion.

- **(Date TBA)**
  - Final draft of Research Papers Due

Selection of Topic

In this project you are asked to investigate the effect of some environmental factor on a Wisconsin Fast Plant. When you pick a topic please take the time to find something that interests you. Consider the amount of time that you will be able to give daily once your experiment begins. You need to be able to make thorough observations at roughly the same time each day.

Since every experiment is different, I cannot give you an exact length of time that your experiment needs to run. However, it is important that you are **realistic** about the length of time needed to provide valid & reliable results. Some experiments may require up to 6 weeks. For example, measuring plant growth for one to two weeks is generally not sufficient, especially if you are starting with seeds.

Part 1: Introduction to Research Paper

Part I: Introduction

This is the part of the paper that sets the stage for your reader. In this section you will offer a rationale for your experiment as well as provide sufficient background information starting with the general and becoming more specific.

Problem/Question:
Begin by identifying the question you are attempting to answer through research & experimentation.

Rationale:
This is where you explain why you want to answer the above question. In other words, why are you doing the experiment? Go beyond the obvious, that you are doing this as part of a class assignment; instead explain why you selected this specific topic. Why does this topic interest you? Also, try to think on a broad scale. Stay away from saying you selected working with hamsters because you think they are cute or that you are working with bacteria because it is easy. Concentrate on the benefit of your results; how can your results be used in the future?

RESEARCH / Background Information:
In this part of the introduction you are laying the foundation for your hypothesis. You need background information on both the organism used and the environmental factor (independent variable) changed. For the organism you are concentrating on what is normal behavior/growth/color, etc.

> **Example:** Background information on plants might include normal growth requirements such as, amount of light, temperature, quantity and frequency of water, proper pH, and type of soil. Also look for information to describe normal color and growth – paying attention to the factors that will be measured during the experiment.

The information on environmental factors (in most cases, the independent variable) should explain what it is and how it is supposed to affect organisms. If you can find examples of how it affects other organisms, include it.

> **Example:** Information on the formation of acid rain and why it is important to study it should be provided (this helps to support the rationale). The harmful effects of acid rain – its corrosive properties should be provided. When possible provide examples of how acid rain affects nonliving materials such as marble and brick, as well as living things as it lowers the pH of the environment. Also, include information on ways to combat the effects of acid rain, and examples of areas currently affected by acid rain.

Things to remember while researching:
As you are searching, keep detailed records. Make sure you **record the sources you have used,** whether helpful or not, and the keywords that you worked with. This will help you if you have to do more research and in compiling the sources used in the bibliography.

Your research paper should include 'RESEARCH' or information that you have taken from other sources. Each time you include information from a source you should cite that source in the body of the paper using parenthetical references (the author's last name and page number(s) are placed in parentheses in the text to give credit to sources).

Hypothesis

Your rationale and background information should lead into your hypothesis. The information that you have presented in the preceding two sections should provide the reader with an understanding of why/how you developed this hypothesis. Again, make sure your hypothesis is:

- clear
- testable
- supported by the background information
- written in the form of a statement (not a question)

Example: The weekly application of acid rain (pH 4.5) will make the plant lighter in color and will stunt the growth.

❖ **Once approved, any changes to your project/hypothesis must be cleared with the teacher. Changing your topic without notifying the teacher may result in a failing grade for your research project.**

Sources Cited

This is what you usually call a bibliography. The difference is that the only sources listed here are ones that you refer to in the body of your paper. The sources are to be listed in alphabetical order by the author's last name. You are not allowed to cite a general encyclopedia – it can be used to help you find background information, but you need to find more specific details in a different source. Also single space within an entry but double space between them and have the first line start at the left margin while indenting the other lines. Be sure to follow proper MLS format.

Part 2: Experimental Design (Materials & Methods)

Materials:

In this part of the paper you will list (bullets are a nice touch) all the materials that are needed to conduct the experiment from start to finish. The quantity of each item should also be included.

❖ ***This should not be done in paragraph form.***

Methods:

This is the procedure that you plan to follow. You need to write it with enough detail so anyone could do the experiment EXACTLY the same way you did. Follow the guidelines below:

- Provide details, especially of those methods that are unique to your experiment.
- Write out the procedures in a step-by-step format.
- Number each step.
- Write in past tense (you have already done the experiment) and use passive voice.
  Example: use "The plant was watered every day . . ." instead of "I watered the plant every day . . ."
- Identify the organism used with the scientific and common names, also mention age if appropriate and where you obtained it.

- Describe any apparatus/chemical that is unique to your experiment – don't assume that your reader is familiar with all equipment/chemicals.
- Identify the difference between the control and the experimental organisms.
- Describe the normal care of the organisms (this is typically the care of the control) such as feeding/watering schedule, temperature and humidity of habitat, living accommodations, light source and distance from other organisms (if applicable).
- Explain when you will make observations and what those will be – measure length/height/width/mass, behavior, color changes, respiration changes, performance of a task.
- **Provide a photograph or a sketch of the set up on the first day of your experiment.**
- Include any safety precautions that you need to follow – address any possibilities, no matter how insignificant you feel they are. If you have a light or heater for your organism, be sure to address fire safety!
- Identify the ways that you will be disposing of the materials after they have been used; include clean up procedures for when the experiment is in progress.
- Make sure your experiment tests your hypothesis.

Part 3: Results

This is the section where you show how you plan to present your data. You must include a data table, graph & pictures/diagrams. Do not make any comments about the results in this section. Simply report the data and any observations.

- *Do say: A leaf from the "sunny" plant was observed to contain starch.*
- *Do not say: A leaf from the "sunny" plant was observed to contain starch* because it was exposed to sunlight.

You need to make sure the presentation of your data/observations is clear and easy to read. Don't assume that your reader knows exactly what you were doing. You can clear up any potential confusion by avoiding the use of abbreviations (except units for measurements), writing a detailed title for any figure or table, using units with each measurement, and providing a reference point for any descriptions (exactly what is meant by "big" or "greenish"?).

Tables and Figures

- A table is what you might call a chart – it is information presented in rows and columns
- Every *table* should be labeled by a number and have a title at the top so that they can be easily referred to in the discussion.
  Example: "Table 3: Daily change in height of each plant"
- If it is a picture/diagram or a graph then it is called a *figure.*
- A figure should have a number and title at the bottom – leave space for it
- Make sure the axes of the graph are spaced evenly (one square has the same value all along the axis) and labeled
- Label the units with all measurements – at the top of the columns in a table and along the axes of a graph
- Use grid lines around the information in a table – this makes it easier to read
- Group similar data in a column, not a row.

Journal/Daily Log

- A daily/weekly log or journal of observations needs to be kept in a composition notebook. This will need to be turned in with your final research paper.
- Qualitative and quantitative data should be recorded for each entry.
- Use descriptive words to provide as much detail as possible. You want to create a mental picture.
- Sketches or drawings may be used in addition to your observations.
- The interval of each entry will vary depending on the experiment. If you are uncertain about the minimum number of observations that should be recorded, check with your teacher.

Part 4: Discussion

The discussion is perhaps the most important part of your lab report - but often the most challenging. This is where you provide an interpretation or explanation of your results. Do not simply restate your results - you already did that in the results section. You must discuss what they mean and why they are important. Discuss what you were able to learn from your results. In this section the author (you) is expected to analyze and interpret the investigational data relative to the objectives described in the Introduction.

In this part of the paper you will pull all the parts together. Readdress your hypothesis and relate your results to it. Determine the success of the experiment and support this with specific results. When you are discussing the success of your experiment consider the significance of your results. An 10 cm experimental plant that is only 0.1 cm bigger than the control plant is not significant. But a .1 cm difference in the average growth of 100 earthworms might be. This would be a good place to calculate percent difference/error. If a calculation is not possible, use your best judgment on what is a significant difference. Perhaps your decision could be that the experiment was successful in testing the hypothesis, but did not significantly support the hypothesis. You may conclude that more experimentation is needed to support or reject the hypothesis. When discussing your success/failure start with specific information – the important results of your experiment by referring to the data and the table/figure in which the information can be found. Remember, it is ok if your experiment did not support your hypothesis. You have not failed the assignment; you just have to provide a reasonable explanation for your results.

> **Example:** The plants watered with acid rain (pH 4.5) grew considerably less than the control plants (average of 2 inches compared to 5 inches) as shown in Table 1.

Offer a detailed explanation of your results. Pick the most likely explanation; don't mention every possible option-as some obviously won't apply to your work. As you are explaining your results you should refer to information gathered while you were doing your background research – you can pull in points mentioned in your introduction. You should also refer to similar experiments. This will help to support your results by agreeing with your findings or showing that your hypothesis was correct but results were flawed. Don't worry if similar experiments don't agree with your own; the comparison still needs to be made.

> **Example:** Acid rain stunted the growth of the plant because the acid burned the roots, making it more difficult for them to absorb the necessary minerals and water. The acid also reacts with the minerals and nutrients in the soil making them unavailable to the plant. A study conducted by Jane Doe (15) showed pine trees exposed to acid rain (pH 5.0) grew 3 times slower than those watered with normal rain water (pH 6.5)

Discuss possible sources of error. These could include:

- error due to not following directions

- design errors – not having the right living conditions
- sampling errors – sample size, population/organism selected
- measurement, record keeping or calculation errors

Only mention errors that are most likely to have affected your experiment. If I knew that I measured the pH of the acid rain accurately I would not include this as a part of my error. One error that should always be included is sample size. You are not using enough organisms and need to consider individual differences and their influence on your results. For each error you mention you should offer a reasonable and detailed improvement. Don't just say "The sample size should be larger" but give a specific sample size.

End your discussion by referring back to the rationale in your introduction. Discuss whether or not your results can be used in the way you stated. Give other examples of how you can use your results. A good experiment also generates more questions than it answers. This would be a good place to make suggestions for future experiments – those that will expand on your findings.

Part VI: Sources Cited

This is what you usually call a bibliography. The difference is that the only sources listed here are ones that you refer to in the body of your paper. The sources are to be listed in alphabetical order by the author's last name. You are not allowed to cite a general encyclopedia – it can be used to help you find background information, but you need to find more specific details in a different source. Also single space within an entry but double space between them and have the first line start at the left margin while indenting the other lines. Be sure to follow proper MLS format.

You need a minimum of four sources that you cite in your paper. **Example:**

McMillan, Victoria E. 1997. Writing Papers in the Biological Sciences, 2nd Ed. Boston:
Bedford Books. pages 120–145.

Stover, Dawn. 1999. Sizing Up Terror Crocs. Popular Science. 255(3):33.

Overall / Misc. Requirement:

- **Experiment tests hypothesis**
- **Paper is clear/concise**
- **Proper sequence is followed.**
- **Typed**
- **Double spaced**
- **1 inch margins**
- **Times New Roman, 12 point font (or something comparable)**
- **All components included**
- **Spell Check performed**

- **No major grammatical errors**

Sources:
- Gallant, Trevor (KV High School, Canada) http://kvhs.nbed.nb.ca/gallant/biology/lab_report_format.html
- Stiles, Laura (Wakefield High School) *Project Guidelines*.

Questions to Guide Analysis:
Embedded in the instructions.

Rubric: See planning sheets.

Honors Biology Research Paper – Part I		
Component: Place a check next to each question, once you have completely answered it (in the provided space).	**List all sources of Information used to support these statements**	**Number of the Corresponding paragraph(s)**
I. Topic		
___ What question are you trying to answer? ♦ **This must be a question you can answer *scientifically*!** ♦ **You must be able to obtain *measurable* results?**		
II. Rationale		
_____ Why does the topic interest you?		
_____ How will anyone else benefit from your results?		
III. Background Information (RESEARCH):		

Honors Biology Research Paper – Part I		
Component: Place a check next to each question, once you have <u>completely</u> answered it (in the provided space).	**List all sources of Information used to support these statements**	**Number of the Corresponding paragraph(s)**
A. Organism used in the experiment	***Source Cited***	**Paragraph #**
_____ What is the common name?		
_____ What is the scientific name (2 word name, in Latin, usually italic print. The first word always begins with a capital letter, the rest is lower case)?		
_____ Normal behavior/appearance (what would I see if I was looking at it – how is it different from other organisms like it)		
_____ Normal growth (How rapidly does it grow? Is there a particular time that it grows best? How long does it take to complete a normal life cycle? Reproduction rate?...)		

Honors Biology Research Paper – Part I		
Component: Place a check next to each question, once you have <u>completely</u> answered it (in the provided space).	**List all sources of Information used to support these statements**	**Number of the Corresponding paragraph(s)**
_____ What time of year can your organism be found. When is it most likely to survive/grow (consider when you will be conducting your experiment).		
_____ What needs to be done to keep the organism alive throughout your experiment (normal care and feeding).		
_____ Did you use any other sources to support the above information? If so, list them below.		

Honors Biology Research Paper – Part I		
Component: Place a check next to each question, once you have <u>completely</u> answered it (in the provided space).	**List all sources of Information used to support these statements**	**Number of the Corresponding paragraph(s)**
B. Environmental Factors (a.k.a. independent variable):	***Source Cited***	**Paragraph #**
_____ What is the variable that you are going to manipulate or change? (Tell me information about it - not common knowledge!!!)		
_____ How is it supposed to affect the organism/test subject?		
_____ How does it affect other similar/related organisms?		
_____ How do you expect to be able to measure the change caused by the environmental factor? **WHAT IS YOUR DEPENDENT VARIABLE???**		

Honors Biology Research Paper – Part I		
Component: Place a check next to each question, once you have <u>completely</u> answered it (in the provided space).	**List all sources of Information used to support these statements**	**Number of the Corresponding paragraph(s)**
_____ Did you use any other sources to support the above information? If so, list them below.		
IV. Hypothesis	***Source Cited***	**Paragraph #**
_____ What is your hypothesis?		
_____ Do you have background information that supports your hypothesis? (This is what makes your guess *educated…why have you made this prediction?*)		
The above hypothesis: **_____ Is clear & concise (easy to understand without using a bunch of extra words).** **_____ Is testable** **_____ Attempts to answer your initial question.** **_____ Is written in the form of a statement (not a question).** **_____ One to two sentences long (not a paragraph).** **_____ Includes the dependent and independent variable.** **_____ Shows a cause & effect relationship between dependent & independent variables.**		
IX. Sources Cited / Bibliography		

Honors Biology Research Paper – Part I		
Component: Place a check next to each question, once you have <u>completely</u> answered it (in the provided space).	**List all sources of Information used to support these statements**	**Number of the Corresponding paragraph(s)**
_____ Include a Sources cited section at the end of your paper. This lets me know where you got your information from (list **<u>all</u>** sources in alphabetical order):		
_____ Have you followed the proper MLS format (see the handout from class) **_____ Is it listed in alphabetical order?** **_____ Are there at least four sources?** **_____ Is one of the sources a book?** **_____ Is one of the sources a reputable internet site?** **_____ None of the 4 required sources are a general encyclopedia.**		
X. Misc. Criteria		
_____ *Paper is Typed* _____ *Cover Page includes project title, student name(s), and block number* _____ *12 Point Font (maximum)* _____ *Margins should be exactly 1 inch (this includes top & bottom too)* _____ *Double spaced* _____ *Paper has a professional appearance* _____ *Information is organized; appears if time was spent putting it together.* _____ *Spell check was performed* _____ *Proper grammar* **_____ You have read through your paper to see if it logical and flows smoothly.**		

Peer Review: Honors Biology Research Paper – Part I	
(+) The component has been effectively addressed (2 Points). **(-) The component has been addressed but more information is needed (1 Points).** **(0) They have failed to address the component adequately (0 Points).**	
I. Topic	
_____ The question they are trying to answer has been stated _____ The question can be answered *scientifically* _____ It is possible to obtain *measurable* results	
II. Rationale	
_____ They have addressed why the topic interests them _____ They have identified how others will benefit from their results	
III. Background Information (RESEARCH):	
A. Organism used in the experiment	**Comments**
_____ The common name is given	
_____ The scientific name is stated	
_____ Normal behavior/appearance _____ What would I see if I was looking at it? _____ How is it different from other organisms like it?	
_____ Normal growth _____ How rapidly does it grow? _____ Is there a particular time that it grows best? _____ How long does it take to complete a normal life cycle? _____ Reproduction rate	
_____ What time of year can the organism be found?	
_____ What needs to be done to keep the organism alive throughout the experiment (normal care and feeding).	

Peer Review: Honors Biology Research Paper – Part I	
B. Environmental Factors	**Comments**
_____ They identified the variable they are going to change.	
_____ How is it supposed to affect the organism/test subject?	
_____ How does it affect other similar/related organisms?	
_____ How do they expect to be able to measure the change caused by the environmental factor? (this is the dependent variable)	
IV. Hypothesis	
_____ The hypothesis has been stated. _____ The research supports the hypothesis. _____ The hypothesis is clear & concise (without a bunch of extra words). _____ It is testable. _____ Attempts to answer the initial question. _____ The hypothesis is written in the form of a statement (not a question). _____ It is one to two sentences long (not a paragraph). _____ The hypothesis includes the dependent and independent variable. _____ Cause & effect relationship shown between dependent & independent variables.	

Peer Review: Honors Biology Research Paper – Part I
V. Sources cited / Bibliography
_____ Includes a Sources Cited section at the end of your paper. _____ Sources are cited in the body of the paper. _____ Proper MLS format _____ Listed in alphabetical order? _____ Are there at least four sources? _____ Is one of the sources a book? _____ Is one of the sources a reputable internet site? _____ None of the 4 required sources are a general encyclopedia.
Misc. Criteria
_____ ***Paper is Typed*** _____ ***Cover Page includes project title, student name(s), and block number*** _____ ***12 Point Font (maximum)*** _____ ***Margins should be exactly 1 inch (this includes top & bottom too)*** _____ ***Double spaced*** _____ ***Paper has a professional appearance*** _____ ***Information is organized*** _____ ***Appears if time was spent putting the paper together*** _____ ***Spell check was performed*** _____ ***Proper grammar is used throughout the paper*** _____ The information in the paper is logical.

Peer Review: Honors Biology Research Paper – Part I
_____ The content of the paper flows smoothly.

Honors Biology Research Paper Grade Sheet		
(+) You have adequately addressed this component (4 Points). **(-) You have addressed the component, but more information is needed (2 Points).** **(0) You have failed to address the component adequately (0 Points).**	**Source Cited**	**Corresponding paragraph(s) Identified**
I. Topic		
_____ You have identified what question are you trying to answer?		
_____ It is a question you can answer *scientifically*.		
_____ You can obtain *measurable* results?		
II. Rationale		
_____ Why does the topic interest you?		
_____ How will anyone else benefit from your results?		
III. Background Information (RESEARCH):		
A. Organism used in the experiment		
_____ What is the common name?		
_____ What is the scientific name?		
_____ Normal behavior/appearance		
_____ Normal growth		
_____ What time of year can your organism be found. When is it most likely to survive/grow (Does this time coincide w/your experiment?).		
_____ What needs to be done to keep the organism alive throughout your experiment (normal care and feeding).		
Other comments/questions about your test subject that may need to be addressed.		

B. Environmental Factors (a.k.a. independent variable):		
_____ What is your independent variable?		
_____ How is the independent variable supposed to affect the organism/test subject?		
_____ How does your independent variable affect other similar/related organisms?		
_____ How do you expect to be able to measure the change caused by the independent variable (what is your dependent variable?)		
Other comments/questions about the environmental factors that may need to be addressed.		

IV. Hypothesis

Your hypothesis:

_____ Is supported by your background information?

_____ Is clear & concise (easy to understand without using a bunch of extra words).

_____ Is testable

_____ Attempts to answer your initial question.

_____ Is written in the form of a statement (not a question).

_____ One to two sentences long (not a paragraph).

_____ Includes the dependent and independent variable.

_____ Attempts to show a cause & effect relationship between dependent & independent variables.

Questions/Comments about your hypothesis.

Miscellaneous

_____ Sources were cited in the body of the introduction

_____ Sufficient research and effort are evident in the product that was turned in.

Additional Comments:

V. Materials

_____ All materials are included.

_____ List format.

_____ Quantity of each item is included.

_____ Identify where item can be obtained if not a common household item.

VI. Procedures

_____ Numbered/step by step format (not in paragraph form).

_____ Written in complete sentences.

_____ Includes details/ procedures are complete.

_____ Logical.

_____ Written in past tense

_____ Describes care/upkeep of organism(s).

_____ Includes a **PHOTOGRAPH OR SKETCH** of the actual **SETUP (Day 1)**.

_____ Explains when observations were made/recorded.

_____ Explains how observations were taken and recorded.

_____ Safety precautions are addressed.

VII. Data/ Results / Observations

A. Data Tables

_____ At least one data table has been provided

_____ Data table is labeled with a number (Table #:) and a title

_____ All rows & columns are clearly labeled.

_____ Table is set up in a logical manner

_____ All units are labeled

B. Graphs

_____ At least one graph has been provided

_____ Graphs are labeled with a number (Figure #:) and a title

_____ Each axis is labeled.

_____ Graphs are set up in a logical manner (remember the rules of graphing indep. & dep. variables)

_____ All units are labeled (use SI units when possible)

C. Observations

_____ A journal or daily log was kept throughout the experiment to record observations.

_____ Qualitative & quantitative observations were made throughout the experiment

_____ Observations are descriptive and appear accurate.

_____ **Includes photos or sketches of results**

VIII. Analysis and Conclusion

_____ You have attempted to explain the outcome (or trends) of your graph.

_____ Was your experiment actually set up to answer your initial question?

_____ If your experiment does not answer your question, have you explained why it doesn't?

_____ Did your data *support* or *reject* your hypothesis. Explain!

_____ Why do you think it did/did not support your hypothesis (possible causes).

_____ You have identified some things that went well with your experiment.

_____ You have identified some things that did not go well with your experiment.

_____ You have listed the most probable sources of error.

_____ Show the value of your results (readdress your rationale… is there any worth to your finding?).

_____ Describe possible future experiments that could be conducted (to expand upon your findings).

_____ Spell Check performed

_____ No major grammatical errors

IX. Sources cited / Bibliography

_____ Have you followed the proper MLA format (see the handout from class)

_____ Is it listed in alphabetical order?

_____ Are there at least four sources?

_____ Is one of the sources a book?

_____ Is one of the sources a reputable internet site?

_____ None of the 4 required sources are a general encyclopedia.

X. Misc. Criteria

_____ Paper is Typed

_____ Cover Page includes project title, student name(s), and block number

_____ 12 Point Font (maximum)

_____ Margins should be exactly 1 inch (this includes top & bottom too)

_____ Double spaced

_____ Paper has a professional appearance

_____ Information is organized; appears if time was spent putting it together.

_____ Spell check was performed

_____ Proper grammar

_____ You have read through your paper to see if it logical and flows smoothly.