

Sixth Grade Science

Project Packet:

The Eight Steps of Experimental Design



Your project must have the following 8 steps. Your display board is the place to show these 8 steps and the roman numerals along with your creativity!

- I. Statement of the Problem
- II. Hypothesis
- III. Operational Definitions
- IV. Controls

V. Materials

VI. Procedures

VII. Observations

VIII. Conclusion

SCIENCE PROJECT PACKET

For Advanced 6th grade students

(Keep this page with your project packet)

Date assigned: October 22nd and 23rd

Date Due: Feb 16th and 17th, 2016

This project will count as **two test grades (for the project) and one daily grade (for the oral presentation)**. Your teacher may assign additional grades for this project at his/her discretion.

- ❑ You may choose to do this project alone or with a partner. It is recommended that you work alone. If you decide to do this project with a partner, you may choose him/her from this class only. (They may not be from another 6th grade team.)
- ❑ **Caution:** Be sure to choose a person who is responsible and dependable. Be sure that you will not have trouble arranging time, place, and transportation to meet while working together.
- ❑ **It is each partner's responsibility** to make sure that the project is completed on time and that each student puts forth appropriate time and effort.
- ❑ **It is not the teacher's** responsibility to assure that each partner contributed the same amount of effort to the project.
- ❑ If working with a partner, **each partner must produce their own checkpoints, Research report, their own Project report, and their own Field Notebook.** They may share research materials and naturally will share data and all that is involved in the project.
- ❑ Partners will turn in only **one Display Board that was produced by both of them.**
- ❑ Partners will present the project together to their class.

Notice: All projects will need to have prior teacher approval.

Notice: Students may not do projects that involve non-human vertebrate animals, pathogenic agents (all bacteria, mold, fungi, etc.), controlled substances, human or non-human vertebrate tissues or other hazardous biological agents. Projects involving explosives or projectiles such as BBs, pellet guns, potato guns, paint ball and other ballistics are not allowed. Projects using human subjects or combustible materials are also not permitted.

I have read and discussed this packet with my child.

Web sites that may be helpful in generating ideas for a science project:

http://www.sciencebuddies.org/science-fair-projects/project_ideas.shtml

<http://sciencefairproject.virtualave.net>

<http://members.ozemail.com.au/~macinnis/scifun/projects.htm#N42>

<http://tinkerlab.com/science-fair-project-ideas/>

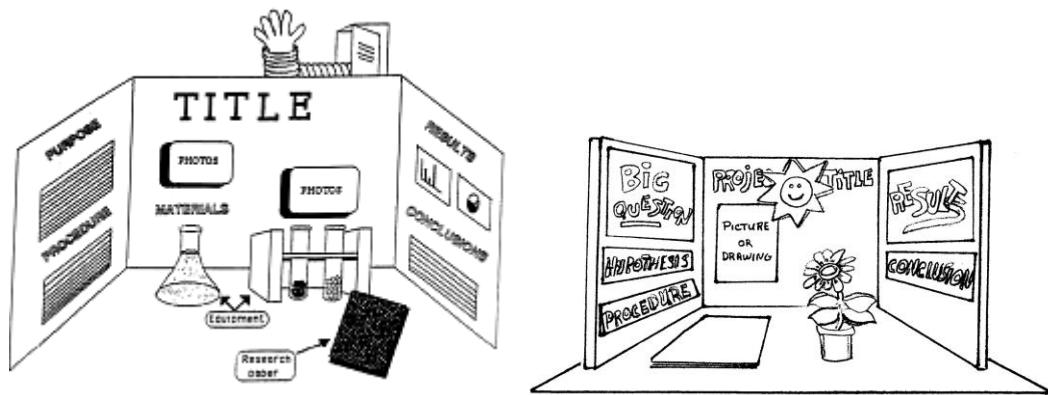
<http://www.education.com/science-fair/sixth-grade/>

Note that your teacher will not approve all projects listed on these sites. Your project must include testing and measuring, you must have an independent and dependent variable, the difficulty level must be appropriate for an advanced middle school student.

Caution: *It is appropriate to get ideas for a Statement of the Problem from the internet. However, the experimental design should be your own. Your project should extend our understanding of the topic in a new and original way. Do not just download someone else's science project, follow the procedures, and turn it in as your own.*

Be Creative

Finally display the 8 steps of Experimental Design with creativity. A great looking board is an attention getter that will sell your idea.



Project Requirements:

In addition to selecting project topic, designing and performing experiments, as well as collecting data, you will produce:

- A **Research report** on your topic
- Keep a **Field Notebook** (a “sloppy copy” of the 8 steps that includes your data as you are actually collecting it)
- Design and produce a **Display board**
- Produce a **PROJECT REPORT** detailing the 8 steps
- You may also choose to make a model, if appropriate.

1. RESEARCH REPORT Requirements: (*This is done prior to starting your project*).

This report needs to include the following:

Introduction:

- What is the project about (Statement of Problem...) and how did you become interested in the topic.
- What you already know about the problem that you will investigate?
- What you hope to learn from your investigation?

Body:

Summary of new information you found using 5 sources:

- Be sure to ***use 5 different types of sources:***
 - Written – one book source
 - Written – one magazine, professional journal source
 - Written – one newspaper article
 - Interview someone knowledgeable about the topic.
 - *Internet – no more than 2 science web sites* (after you have the 5 required types of sources, you may have additional websites).

Concluding paragraph:

- How will the results of your project benefit others? (Assume that whatever you are doing has never been done before).
- What new and interesting information did you learn about your project topic? How will this help you do your project?
- Typed report must be about 2 pages in length, double-spaced. Use font size 12.*** If hand-written, the report must be neat, with good penmanship, blue or black ink, double-spaced, about 4 pages long.

Bibliography: All 5 sources must be documented. Use the sites listed below if you need instructions on how to do this.

Bibliography Instructions

<http://www.easybib.com>

<http://www.citationmachine.net>

<http://bibme.org>

Or you can use google docs, here are the steps to use it:

- Highlight name or subject you want to cite
- Go to tools
- Research
- Hover over source you want to use
- Click cite, should appear in footer of document

2. FIELD NOTEBOOK:

- Use a regular sized spiral notebook or composition book.
- Shows “scratch work and planning ” for each of the 8 steps.
- Shows **record of all observations at the time of data collection.**
- Must be kept over the entire period of the experiment.
- All entries **must be dated.**
- All quantitative data must be recorded in **metric units.**

3. DISPLAY BOARD

- Must show **all 8 steps** of the scientific method.
- The steps should be arranged in logical order.
- Must display data in charts and graphs.** Use line graphs whenever appropriate.
- Use photographs if possible. Be sure to credit source.
- Use pictures and diagrams as appropriate. Be sure to credit source.
- Should be well constructed and pleasing to view.

4. PROJECT REPORT REQUIREMENTS

Project Report Requirements: *Includes a title page, table of contents, research report, all 8 steps of the Scientific Method (also known as Experimental Design) and a bibliography.*

Title Page:

(example of a title page):

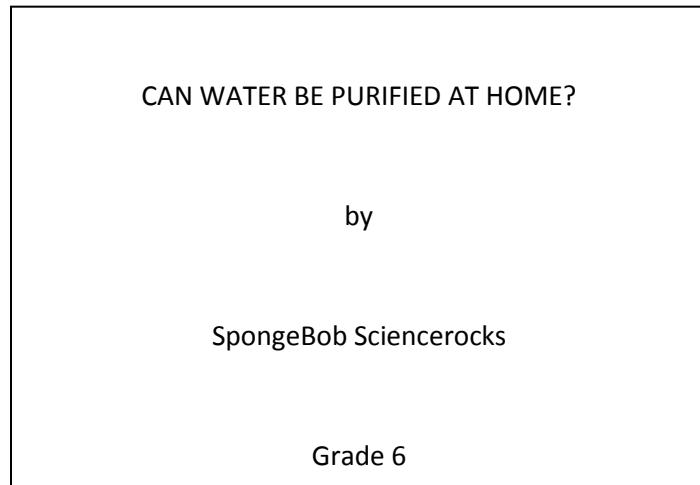


Table of Contents:

(example of a table of contents)

Table of Contents:	Page
Research report	1, 2
Project report:	
Statement of Problem	3
Hypothesis	3
Operational Definitions	3
Controls	4
Materials	5
- - .	- - -

Be sure to include and label all 8 steps of Experimental Design (the scientific method) in order. We have

covered the application of each step in detail. You have a typed summary of the steps on the typed notes of the 8 Steps of the Scientific Method. Please use the notes as a reference, they not only define each step but they also include examples of how to write each step.

Hint 1: In step VII OBSERVATIONS, be sure to record qualitative as well as quantitative observations. Quantitative observations should be made in **metric units** and displayed in **charts** (tables) and appropriate **graphs**. If you do not know how to make a computer-generated graph, construct them using graph paper and pencil.

Hint 2: You may choose to take photographs throughout your project to help demonstrate your results. If so, be sure that you do not appear in the picture.

Hint 3: You may choose to include diagrams or drawings if appropriate.

Hint 4: Put both reports in an attractive folder!

Writing the Statement of the Problem and Hypothesis

The Statement of the Problem and the Hypothesis are the first two steps. They are the very foundation of your investigation! ***The Statement of the Problem and the hypothesis are always closely linked and affect each***

other. They determine what type of project that you have chosen to do. These two steps will be looked at together.

I. Statement of the Problem

Write a statement or question that identifies a problem that we must solve. A science project (investigation) is not a report nor is it a collection. Naming the parts or a simple explanation of how or why something works is not an investigation. A scientific investigation is a step by step inquiry, which includes testing and measuring. Choose and state your problem carefully. Please consider these factors when choosing a topic:

- ✓ Does it involve testing and measuring? *You must have testing and measuring or it is not considered a Science Project!*
- ✓ Is the cost reasonable?
- ✓ Can I meet my deadline (time frame)?
- ✓ Is the scope reasonable (not too broad)?
- ✓ Is this a safe project?
- ✓ Is this project useful to others?

Two Basic Types of Projects

The Statement of the Problem is usually written in the form of a question. There are two basic types of investigations you can do; and therefore, two types of questions. Pick the type that suits your idea.

Two Types of Projects

1. What is best/worst?

Example Statement of the Problem

Which paper towel is most absorbent?

2. What is the effect of A on B? What is the effect of Vitamin C on banana plant growth?

II. Hypothesis

The hypothesis is an educated guess, a prediction as to what we think the solution of our problem will be. It is always a statement of what we believe will result from our testing and measuring before proceeding. Now look at the two types of projects below, the statements of the problem and the hypothesis that comes from each type of statement.

Two Types of Projects

Example Statement of the Problem

1. What is best/worst? Which paper towel is most absorbent?

HYPOTHESIS: Bounty paper towels are most absorbent.

Example Statement of the Problem

2. What is the effect of A on B? What is the effect of vitamin C on banana plant growth?

HYPOTHESIS: One thousand milligrams of vitamin C weekly will increase banana plant growth.

Your Statement of the Problem can become the title of your project or you can think of a title that is more of an attention getter like “Going Bananas Over Vitamin C!” or “Don’t Cry Over Spilt Milk!” for the paper towel experiment.

Caution: If you choose to do a “What is best/worst” type of project, **do not** use those words anywhere on the project (best/worst). These are opinion words that should be avoided. Notice that neither of those words was used in the Statement of the Problem for the paper towel experiment. Instead, the words “most absorbent” were used.

Note: In addition to the example investigations discussed in this packet, students may not use the helicopter lab or vitamin C testing of as a Science Project. There are millions of ideas. Please come up with a different idea.

What is the effect of A on B?

Display board example of steps. I. Statement of the Problem and II. Hypothesis

I. Statement of the Problem:

What is the effect of vitamin C on banana plant growth?

II. Hypothesis

III. Operational Definitions

Next, we will complete the operational definitions section of the display board. Start by circling every major word that appears in your Statement of the Problem and Hypothesis. Define them. Remember, when in doubt – define it! Again, avoid using these words: best, better, worse, pretty, ugly, right, wrong or other opinion words in both the Statement of the Problem and the Hypothesis.

I. Statement of the Problem:

What is the effect of vitamin C on banana plant growth?

II. Hypothesis

One thousand mg of vitamin C weekly will increase banana plant growth.

Things to remember about operational definitions:

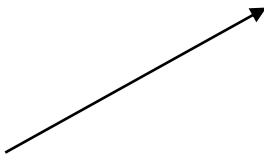
- ✓ Write them in a list format – not a paragraph
- ✓ Define all key words that appear in the Statement of the Problem, Hypothesis or anywhere else in the project.
- ✓ These definitions are specific to each individual project
- ✓ Common words vary in meaning

Display board example of Operational Definitions.

III. Operational Definitions

Growth – growth is measured in plant height

Vitamin C – a complex substance essential to good health. A deficiency of this in human diets results in scurvy. Manufactured and distributed in tablet



Note: It is possible to have more than one way to measure growth. For example: height, trunk circumference, number of new leaf sprouts. We picked one thing to measure growth to keep it simple. See "More Complex Experimental Designs" at the back of the packet if you want to measure more than one dependent variable.

*See the helicopter lab for operational definitions from that investigation.

IV. Controls

We must list all variables, which are the elements that can change or influence the results of our investigation. We MUST keep our tests and measurements absolutely fair and honest by controlling variables. Some important variables: time, quantity, quality of materials, temperature. Use **metric units** for measurement.

You should list 3 kinds of variables. The following terminology is recommended by the International Science and Engineering Fair. Also, see other notes in your notebook and page 18 in your textbook for a review.

1. **Independent variable** – this is the variable that you can change, sometimes called the “manipulated” variable. This is the variable you are testing.
2. **Dependent variable** – this is the variable that we observe. Sometimes called the “responding” variable. This variable is affected by changes in the independent variable. Use a journal (spiral notebook) to record observations of your dependent variable(s) over time. You can think of the dependant variable as the outcome data. You should quantify it, build data tables and graph those data tables!
3. **Controlled Variables** – These are variables that can affect the outcome of an experiment. These are the variables that should be controlled. They should remain the “same” or “constant”. *DO NOT tell us how you controlled these variables here.* That should happen under step VI. Procedures and step V. Materials. Just list those variables that must stay the same.

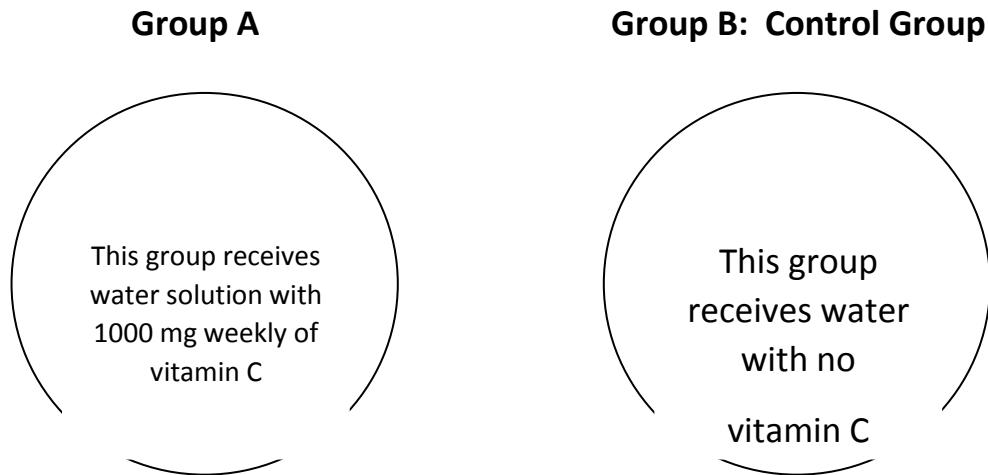
Note: Many students find it easier to go to the next step of the Scientific Method (Step VI. Procedures) before making their list of controlled variables. It may be helpful to write detailed procedures first and then, afterwards, return to this step to list the variables that are controlled under step VI. Procedures. Writing detailed procedures first forces you to think about exactly how you will control the experiment. Either way, here is what an example control section of your display board should look like.

Depending on the type of project you do, the **IV. Controls** section of your display board may look differently. But all display boards should list 3 kinds of variables: independent, dependent, and controlled variables.

Note: You can use the term “manipulated variable” instead of “independent variable” and “responding variable” instead of “dependent variable” if you like.

Using a Control Group

When performing a “what is the effect of A on B?” type experiment there is a great opportunity to use experimental groups and in particular a control group. A control group is an extremely powerful way of demonstrating control over an investigation and showing the effect of the independent variable on the overall outcome of the investigation. It is always impressive to see it done right. This type of experiment (What is the effect of A on B?) should have at least two experimental groups and one of those groups should be the “Control Group.” Be sure to distinctly identify your Control Group under **Experimental Groups** under step **IV. CONTROLS**. These groups enable us to answer the question “What happens when “A” does not occur? In other words, **what happens to plants that receive no vitamin C?**



You can have a more complex experimental design simply by adding more groups than the two listed above. For a more complex experimental design, see pages _____ entitled **Additional Experimental Designs**.

Given the statement of the problem mentioned earlier; *What is the effect of vitamin C on banana plant growth?* the controls section of the display board is shown below.

IV. Controls

Independent Variable - Vitamin C

Dependent Variable – banana plant growth (height)

Controlled Variables:

- light exposure daily
- location of plants
- water amount
- time of watering
- watering schedule
- amount of watering with vitamin C mixture
- temperature of environment
- beginning height of plants
- same species of banana plant

Experimental Groups

Group A – includes plants that receive 1000 mg of vitamin C per week in

water solution

V. Materials

The materials section should be an item-by-item list; not a paragraph. At times, some of the variables are indirectly controlled in this section. For

example, “size of banana plants” on the list of materials below, controls the size of the plants at the start of the experiment.

Display board example V. Materials

V. Materials

2 – 5 lb. bags of Miracle Grow potting soil

10 – 1 foot high Little Prince banana plants

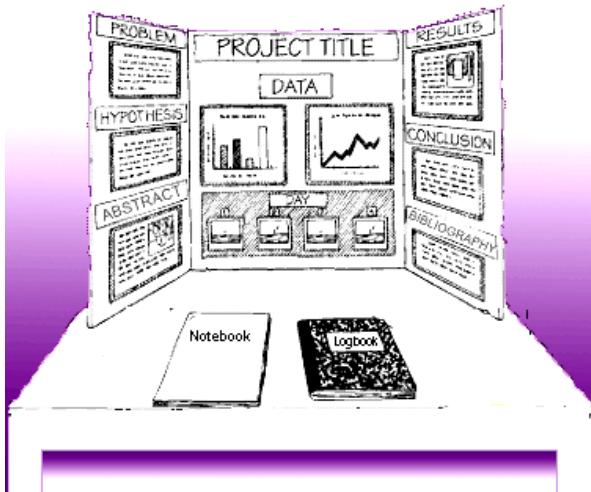
10 – 20 inch diameter terra cotta pots

1 – 1000 mL graduated beaker

1 pestle and mortar

VI. Procedures

This is one of the most important steps. *It is in this step as well as in your materials list that you demonstrate how you controlled the variables listed in step IV. Give as much detail as possible.* This is a step-by-step set of sequential instructions on exactly how you performed the experiment. If others were interested in repeating your experiment, they would simply follow your detailed procedures. It is important that a scientific investigation is repeatable by others.



Display board example VI. Procedures

VI. Procedures

Set up Procedures:

1. Acquire 10 banana plants of the same species approximately 30 cm tall.
2. Fill 10 - 20 in. diameter terra cotta pots with 3 L of Miracle Grow potting soil.
3. Mark 5 pots with a black permanent marker with a large letter "E" (for experimental group). Mark the other 5 pots with a large letter "C" (for control group).
4. Plant all plants approximately 12 cm deep in pots.
5. Water all plants with regular tap water immediately after planting with 500 ml of water.

Experiment Procedures:

6. Crush 1000 mg tablet of vitamin C with pestle and mortar into a fine powder.
7. Get 3 - 2-liter plastic soft-drink bottles for mixing.
8. Divide the 1000 milligrams of powdered vitamin C into 3 piles of 333

VII. Observations

*****ABSOLUTELY NO INFERENCES HERE*****

List or identify all observations as they occur, or shortly thereafter. The data should be displayed in a meaningful way, easy to read and interpret. There are 4 kinds of graphs: pie chart, line, bar, and scatter plot. You can use anyone or a combination of them; however, use line graphs whenever possible. Note everyone owns a computer. I have seen many excellent projects with hand drawn graphs. That is perfectly acceptable! Just make them neat!

For our example below, we graphed height of plant growth to make our point. We could have made a set of graphs for circumference and new leaf growth as well. If you are testing all three, there needs to be graphs and tables for all three.

VII. Observations

List or identify all observations as they occur, or shortly thereafter in your field journal. Your measurements should use metric units.

Later you will display the data in a meaningful way that is easy to read and interpret. Use graphs, charts, photographs, or other displays that are informative and pleasing to view.

***ALL CHARTS AND / OR GRAPHS MUST HAVE A TITLE THAT EXPLAINS ITS PURPOSE**

- *Graphs need to be labeled with an explanation of what the numbers and or words for both the x and y axis mean.
- *The top of each column and row should be titled.
- *Do not use abbreviations.
- *Photographs should have a written description.

*****ABSOLUTELY NO INFERENCES*****

This is just an example. Averages (the mean) are almost always used. Please remember, THE BIGGER THE DATA SET THE BETTER! Large data sets convince us that you spent a great deal of time, and effort. But most importantly, your graphed averages are much more believable: more reliable than data sets with fewer observations. You might want to use other statistics also, including: range, median, and mode where appropriate.

All graphs should have the data table next to them. Also, you can include photographs, or other displays that are informative and pleasing to view. If you include photographs you cannot have pictures of yourself – not even your hands.

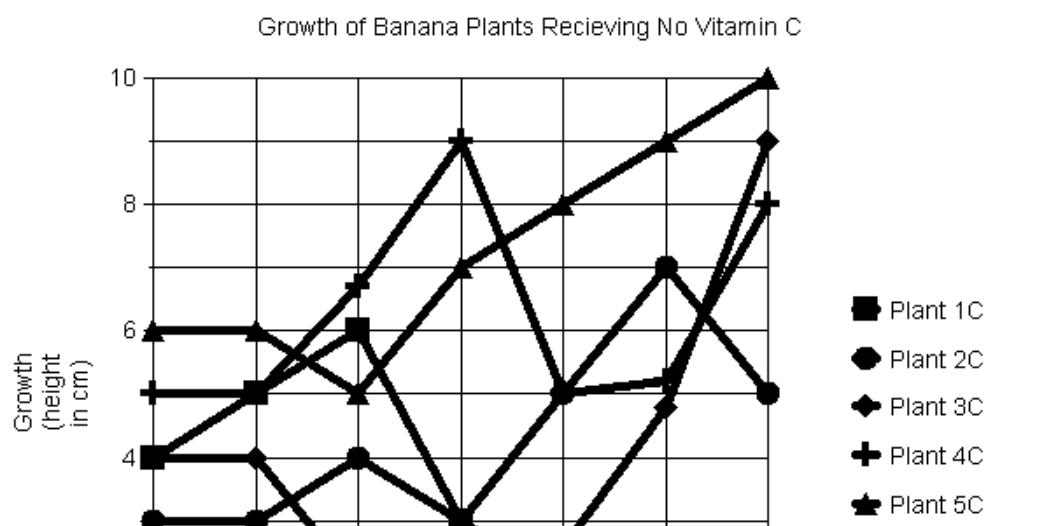
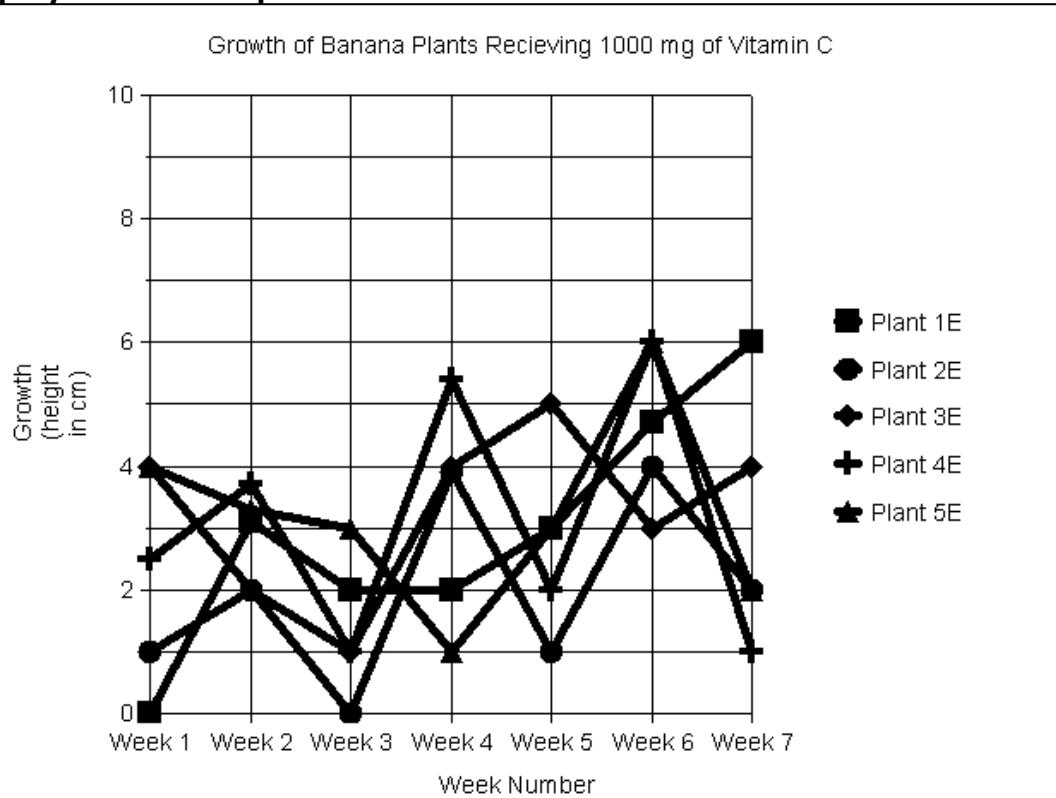
Display board example: VII. Observations

VII. Observations

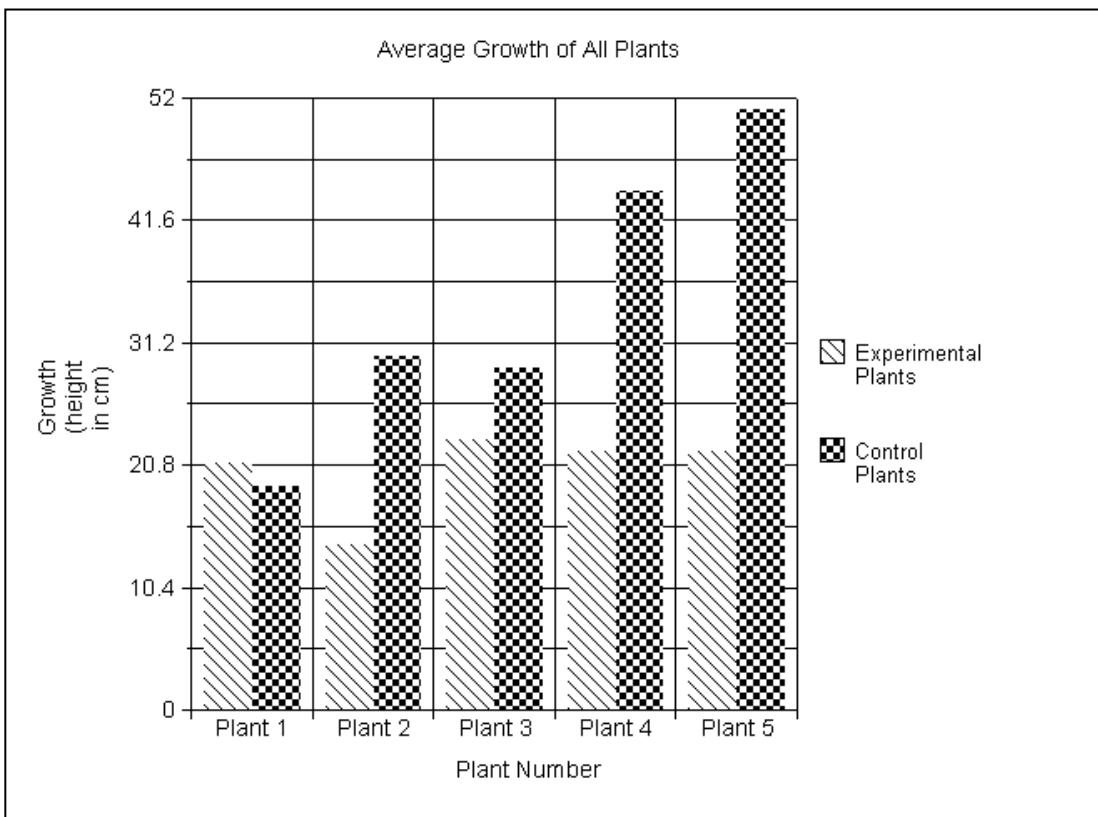
Banana Plant Growth in Centimeters

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Plant 1E	0	3.1	2	2	3	4.7	6
Plant 2E	1	2	0	3.9	1	4	2
Plant 3E	4	2	1	4	5	3	4
Plant 4E	2.5	3.7	1	5.4	2	6	1
Plant 5E	4	3.3	3	1	3	6	2
Plant 1C	2	5	6	3	2	1	0
Plant 2C	3	3	4	3	5	7	5
Plant 3C	4	4	2	2.56	2.59	4.8	9
Plant 4C	5	5	6.7	9	5	5.2	9

Display board example continued... VII. Observations



Display board example continued... VII. Observations



VIII. Conclusion

This should be a simple statement that your hypothesis is true, that your hypothesis is not true, or that your work is inconclusive. This conclusion must be backed by your observations in step VII. Observations. If your work is inconclusive, tell us why. Tell us how you can improve this investigation if you were to conduct it again in the future.

Display board example: VIII. Conclusion

VIII. Conclusion:

My hypothesis was proven untrue by my data. One thousand milligrams of vitamin C weekly does not increase banana plant growth. All but one of the control plants grew more than the plants receiving the vitamin C.

Manage Your Time: Intermediate deadlines for science project:

It is each student's responsibility to budget their time wisely. This timeline is a recommended suggestion. You may not be able to follow it exactly, but you must make every effort to manage your time:

Topic Selection Oct. 29th / 30th _____

Problem Statement Oct. 29th / 30th _____

Start Field Notebook -as soon as you get approval from your teacher _____

5 sources (Bibliography) Nov. 23rd / 24th _____

Research Report Nov. 23rd / 24th _____

Hypothesis Dec. 4th / 5th _____

Operational Definitions Dec. 4th / 5th _____

Experiment:

Controls Dec. 14th _____

Materials	Dec. 14 th	_____
Procedures	Dec. 14 th	_____
Record and Analyze Data		
Data Table	Jan. 16 th	_____
Graph	Jan. 16 th	_____
Conclusion	Jan. 30 th	_____
Display Board	Feb. 6 th	_____
Final Report	Feb. 6 th	_____
Turn in Project	Feb. 16th or 17th	_____
Oral Presentation	Feb. 16 th – 26 th	_____

Name _____ Date _____ Period _____

Scoring Rubric for Project's Oral Presentation:

Student introduced self; gave title of project	Poor 1	Average 2	Best 3
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Explained the Statement of Problem and Hypothesis	1	2	3
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Explained how they got interested in the project; summarized what they learned from their research	2	3	4	6	8
Summarized in their own words how the project was done (Procedures)	3	6	8	10	12
Discussed variables: independent, dependent and controlled variables also control group (if it applies)	3	6	8	10	12
Discussed results: data, charts, graphs	3	6	8	10	12
Discussed conclusion; explained any errors	3	6	8	10	12
Explained what would be done differently next time	3	6	8	10	12
Explained how the results of the project are useful to the world	0	1	2	3	4
Answered reasonable questions completely	0	2	4	6	8

Presentation was smooth (not read from a paper, no long pauses); spoke clearly

	2	4	6	8	10
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Had eye contact, good posture,
thanked the audience 0 1 2 3 4

Scoring Rubric for Research Report/Project Report and Board:

<u>Research Report:</u>	Poor	Average	Best
Accuracy; quality; quantity	1	2	3
Written in student's own words	1	2	3
Five different sources used and cited	1	2	3
<u>Project Report:</u>			
Skills required for experimental design and data collection	2	4	6
Statement of Problem, Hypothesis and experiment are aligned	1	2	3
		4	5
Proper use of operational definitions	0	2	4
		6	8
Recognition of need to control variables	0	2	4
		6	8
Recognition of manipulated (or independent) variable; responding (or dependent) variable	1	2	3
		4	5
All needed materials are listed	1	2	3
		4	5
Procedures are clear and detailed	0	2	4
		6	8
Difficulty required to perform the	0	2	4
		6	8

experiment

Adequate number of trials performed	1	2	3	4	5
adequate time spent	1	2	3	4	5
Observations are comprehensive and clearly written; data analysis, use charts and graphs	0	2	4	6	8
Conclusion derived from actual data	1	2	3	4	5
Field Notebook maintained daily	1		2		3
Includes all required parts: title page, Table of Contents, Research Report, All 8 steps of the Scientific Method,					
Bibliography	1	2	3	4	5

Display Board

Your name is printed on the back; project title is on the front	0			2	
All items are neatly glued or otherwise attached.	2	4	6	8	10
Creativity is evident	2	4	6	8	10
Steps are logically organized	2	4	6	8	10
All 8 steps are shown, labeled and	0	1	2		3

numbered using Roman numerals

Each step includes the needed

Information	6	12	18	24	30
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Step VII (Observations) includes

graphs/charts	5	10	15	20	25
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Written material is in student's

Own words	1	2	3	4	5
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Overall effect	1	2	3	4	5
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I have read and discussed this packet with my child.

Parent signature _____ Date _____

Student signature _____ Date _____

Name _____ Date _____ Period _____

Title of Project _____

Appeal Form for Science Project Grade

Completely fill out this form before turning it into the assignment tray. It is due no later than _____. No incomplete or late appeals will be considered. **Filling out this appeal does not necessarily mean that a grade change will automatically be granted.** You will receive this form back once I have read and considered your appeal. **All materials must remain here until the appeal process is completed.** If you take your project home prior to turning this in, your appeal will not be considered at all. Since all materials must remain here until the appeal process is completed, you may need to stay after school to fill out this form.

Be sure you have gone over the entire Science Project packet of information and have refreshed your memory about what was required on the project prior to turning this in. Also, read through your written report before filing an appeal. If you worked with a partner on this project, BOTH partners need to turn in separate appeal forms. State the SPECIFIC question or statement that you have concerning the grading of this project, using the following format:

- A. Name the Section on the rubric you wish to appeal. Example: "use of operational definitions is specific to the experiment."
- B. Explain in 4 to 6 sentences, in detail, WHY you feel points awarded to you in a particular section should be changed. Be specific. Be sure your reasons are appropriate. For example, just listing the reason "just because" or "I worked so hard on it" or "I didn't know that" or "I forgot" would not be enough. We

have spent time in class learning and applying the steps of the Scientific Method and I offer tutorials so students can come in to ask questions.

You should write your answers on this page or attach another sheet to this page if needed. If your handwriting is illegible I will not attempt to read it.

A. Section of the rubric you wish to appeal.

B. 4 to 6 sentences explaining WHY you feel points awarded to you should be changed. BE SPECIFIC.
