



**McKeel Academy
Science & Engineering Fair
2011-2012 Handbook**



TABLE OF CONTENTS

Section	Page Number
Notes to Parents of Young Scientists	3-4
Tentative Science Fair Schedule	5
Items to Be Finished At Home	6
Setting Up the Logbook	7
Cutouts for the Log Book	8
Choosing a Project	9
Helpful Tips / Do's and Don'ts	10
You've Chosen a Project. Now What?	11
Logbook	12
Setup for Background Information in the Log Book	13
Keeping the Daily Journal	14
How to Write a Bibliography	15-16
Writing the Research Plan	17
Consider This...	18
Variables, Constants, and Controls	19
Research Plan Template	20
Sample Research Plan	21
Metric and Customary Units	22
Tables and Graphs	23
Preparing Your Conclusion	24
Writing the Conclusion	25
Certification Forms	26-27
Abstract	28
Backboard	29
Exhibit Requirements	30
Planning The Oral Presentation	31
Science Fair Research Paper	32
Sample Research Paper	33-44
Logbook Grading Form	45
Backboard Rubric	46
Science Fair Presentation Rubric	47

Notes to Parents of Young Scientists

During the next few weeks your child will begin developing a science project that uses the scientific method to solve a problem. A project is simply a long-term science investigation in which students answer a narrowly defined question by gathering, recording, and analyzing data. A project in this sense is not simply a book report, topic paper, demonstration, or model. Instead, all projects must demonstrate understanding of cause & effect, variables, key science concepts, data collection, & data analysis.

The McKeel Academy Science and Engineering Fair is affiliated with the Polk Regional Science and Engineering Fair, Florida State Science and Engineering Fair and the Intel International Science and Engineering Fair (ISEF). We use the ISEF guidelines, then, as the standard for our school fair. Please visit <http://www.polk-fl.net/staff/teachers/science.htm> for additional resources and help with project planning and investigation.

Teachers will be available to help students throughout the entire science fair process. To participate in a help session, an appointment should be made ahead to time.

McKeel Academy Science Teachers

Help for Parents of Young Scientists

Perhaps this analogy will help to clarify how much help is appropriate to give your child with his/her Science Fair project:

A parent that is a star baseball player spends time teaching his/her child how to be a great pitcher, batter, fielder or catcher. That parent will introduce his/her child to the appropriate baseball equipment, discuss the game rules and strategies and spend many afternoons and evenings playing practice games in the backyard. But... when the child steps out on the diamond to bat in his/her first Little League game he or she has to hit the ball – not his/her parent.

Here are some “idea starters” for providing ongoing help and encouragement for your young scientist:

• ENCOURAGE, ENCOURAGE, ENCOURAGE

- Help your child “brainstorm” for possible project topics
- Do you know someone that can share some information about their chosen topic?
- Help your child develop a personal Science Fair schedule or agenda
- “Let’s look at the Science Fair Handbook together.”
- “Need more background information? How about if I take you to the Public Library?”
- “Let me be sure I have signed and dated all the certification papers.”
- “I’d be glad to help you organize supplies and equipment you need for your investigation.”
- “Let’s keep your project schedule here on the refrigerator so we’ll always know where it is.”
- “Your log is set up well and you are writing your observations very clearly. Your thoroughness is really impressive.”
- “Let’s pick up some film so that we can photograph your project from the beginning.”
- “You are working hard on your project and that makes me very proud. Remember to keep it out of your brother /sister’s reach.”
- “We can pick up supplies while we are at the store so you can begin laying out your display.”
- “Your display is very neat. I like that you have used a paper cutter to make your background construction paper presentable.”
- “You have organized your backboard well. It is neat, interesting and eye catching.”
- “You labeled your graphs nicely. I can get a clear picture of the trends that your data presented from your graphs.”
- “Pretend I’m in your class and let me hear your presentation.”
- “I’m proud of your work and I am proud of you! “

Tentative Science Fair Schedule

August / Early September	
Step 1: Stating the Problem as a Question	
<ul style="list-style-type: none"> • Set up log book. • Write three possible project ideas and choose one. • Determine the category to participate in. • Determine topic(s) in chosen category to research. 	
September	
Step 2: Gather Background Information (Observations and Research)	
<ul style="list-style-type: none"> • Begin library research and bibliography. • In the "Background Information and Research" section of your log book, write a minimum of 15 facts from five different resources. See instructions. (final date TBA) 	
Step 3: Form a Hypothesis	
<ul style="list-style-type: none"> • Write a hypothesis in the "if-then-because" format as discussed in class. (final date TBA) 	
Step 4a: Design an Experiment	
<ul style="list-style-type: none"> • Prepare a detailed list of needed materials and write it in the log book. • List the variables, constants and control (if applicable) in the log book. • Prepare a detailed list of steps for your safety, experimental and data collection procedures and write it in your log book. • Type the final draft of your experiment proposal according to the format discussed in class. • Submit required forms and obtain permission to begin experimentation. 	
October	
Step 4b: Test the Hypothesis	
<ul style="list-style-type: none"> • Gather needed materials for experimentation. • Conduction practice trials (if desired or needed). • Begin experimentation. 	
Step 5: Collect and Record Data	
<ul style="list-style-type: none"> • Collect qualitative data and observations. Record in the "Daily Journal" of the log book. • Collect measurements (quantitative data) and record on hand written data tables in the "Data" section of the log book. • If necessary, set up a time to conduct experiments in class if you need classmates to participate in experimentation. 	
November	
Step 6: Draw Conclusions	
<ul style="list-style-type: none"> • Complete experimentation (final date TBA) • Graphing workshop in class. Complete graph creation and analyze data. Print at least one table and one graph for your project board. (final date TBA) • Write your conclusion in the proper three paragraph format. Hand-write in the log book and type for your project board. (final date TBA) • Complete project abstracts. Print 10 copies and sign each individually. Turn in eight to your teacher. (final date TBA) • Write the research paper and complete the bibliography for your project according to the correct format as discussed in class. See instructions. (final date TBA) 	
December	
Step 7: Communicate with Others	
<ul style="list-style-type: none"> • Complete log books. • Create project boards with format done according to instructions. • Turn in project boards and log book. (final date TBA) • Present projects in class. (final date TBA) 	

Items To Be Finished At Home

Required Certification Forms

- Each student must have certification forms submitted and reviewed prior to beginning of experiment
- Forms may be found online at <http://www.floridassef.net/student/student-forms/>

Log Book

- Entries should be recorded as your experiment progresses
- Write neatly in BLACK ink
- Date every entry
- Carefully record background information
- Record Observations
- Include diagrams or drawings if needed
- Include data table(s)
- Use logbook to record work or conversations with mentors
- Note any problems you have with experiment

Experiment

- Experimentation may not begin until project meets certification review
- Keep list of all materials
- Write down all safety procedures involved with the investigation
- Write down all of your steps in your procedures
- Write down all steps involved in measurements and recording data
- Note manipulated variable, responding variable, constants and control

Tables and Graphs

- Each project must have MEASURABLE results
- Results must be organized in a table in log book
- Each project must have a computer generated data table on backboard
- Each project must have a computer generated graph on backboard

Display Board

- Use a catchy title or a scientific title – your choice
- Back papers with colored construction paper
- Include all information – details in handbook
- Display neatly – sample in handbook

Research Paper and Bibliography

- Type in black print using 12 font Times New Roman or Arial
- Include all information asked for in handbook

Abstract

- Must be completed according to state specifications see handbook for details
- Print a total of 10 completed abstracts and individually sign each.
- Turn in 8 original signed copies on due date

Setting Up the Logbook

Write your name and class on the front of your composition notebook. Write your name, class and title of your experiment on the first page. Number each page front and back in the upper outer corner. Page two then is the back of the first page that you just put your name, class and project title on. Then place the table of contents below on page 3. You do not need to write information in parenthesis. A good idea is to place tabs on the pages outlined below in the Logbook Table of Contents. Create and then cut out the tabs from cardstock. Glue or tape them on the appropriate page – do not use staples. It helps if you “stagger” the tabs as they go down the side of your composition notebook. Some students cover the whole cardboard sheet with clear contact paper before cutting out the tabs, to help preserve the neatness of their logbook.

Logbook Table of Contents

Contents	Page #	Special Instructions
Table of Contents	Page 3	Copy the contents and page numbers shown on this page.
Planning Calendar	Page 5	Staple in extra copy of the schedule given to you.
Project Ideas	Page 7	Write a minimum of three possible project ideas here.
Background Information and Research	Page 9	See pages that follow for instructions.
Problem and Hypothesis	Page 39	Write your problem as a question and your hypothesis as an if/then statement.
Materials	Page 41	Handwrite in your materials including details (amounts, types, etc...).
Variables, Constants and Control	Page 49	Handwrite manipulated and responding variables, constants and the control (if applicable).
Designing the Experiment	Page 53	Handwrite in a detailed list of steps for your safety, experimental and data collection procedures.
Daily Journal	Page 65	Once experimentation starts you must record observations (qualitative data) every day until your experiment is complete. You may place photos in this section.
Data	Page 99	Record measurements (quantitative data) here. Create data tables to record your results – this is mandatory.
Conclusion	Page 129	Write this specifically according to the instructions in the manual. Follow the correct three-paragraph format.
Presentation Preparation	Page 137	Write notes on what you would like to say for your oral presentation.

Cutouts for the Logbook

Log Book Table of Contents

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Planning Calendar	Page 5
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Materials	Page 41
Variables, Constants and Control	Page 49
Designing the Experiment	Page 53
Daily Journal	Page 65
Data	Page 99
Conclusion	Page 129
Presentation Preparation	Page 137

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Step 6: Draw Conclusions
<ul style="list-style-type: none"> Complete experimentation (final date TBA) Graphing workshop in class. Complete graph creation and analyze data. Print at least one table and one graph for your project board. (final date TBA) Write your conclusion in the proper three paragraph format. Hand-write in the log book and type for your project board. (final date TBA) Complete project abstracts. Print 10 copies and sign each individually. Turn in eight to your teacher. (final date TBA) Write the research paper and complete the bibliography for your project according to the correct format as discussed in class. See instructions. (final date TBA)
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Step 7: Communicate with Others
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Choosing a Project

Every project is an application of the Scientific Method:

1. State the problem as a question
2. Gather background information (observations and research)
3. Form a hypothesis and write it as an if/then/because statement
4. Design an experiment and test the hypothesis
5. Collect and record data
6. Draw conclusions
7. Communicate with others

- 🔍 Think about your hobbies and things that you like to do.
- 🔍 Think of something that is measurable.
- 🔍 Choose something that you don't know the answer to.
- 🔍 Choose something that you can work with.
- 🔍 Talk to your teacher if you need extra help.

Try putting different terms in these blanks:

What is the effect of (a) on (b)?

Some of the "a" terms you could use might be:

Temperature, noise, quenching, design, density, humidity, wind direction, overnight minimum temperature, music, pressure, detergent, water turbidity, acid, oxygen

Some of the "b" terms might be:

Seed germination, rusting, growth, rotting, grain size, ripening, wave frequency, bird species, flight duration, surface hardness, learning, driver fatigue . . .

Helpful Tips

- The sites below may help get those creative juices flowing as you think about projects.
- <http://www.polk-fl.net/staff/teachers/science.htm>- Very helpful links!
- Official Science Fair Website: <http://www.societyforscience.org>
- Florida State Science Fair: <http://www.floridassef.net>
- Ideas and help! <http://sciencebuddies.org/>
- For graphing help! <http://nces.ed.gov/nceskids/createAgraph/>

Do's and Don'ts

- Your project must be a scientific investigation (uses the Scientific Method) with a measurable outcome.
- Remember we are not building kits, models (ex. model of a volcano), simply giving a report or creating product comparisons (ex. Which battery lasts the longest?)
- No food will be given to humans as part of experimentation.
- Projects that involve decaying food in ANY fashion are not acceptable.
- Experimentation of humans (even if you are experimenting on yourself only) **MUST** have documented safety procedures, a script, and copies of written tests on file. Physical exercise or projects involving stress, even if you feel there is no risk, require appropriate supervision. Make sure you plan on completing these projects on a “Be a Subject” afternoon.
- Your teacher **MUST** approve microbiology projects that involve any type of bacteria, mold, or fungus study before completing certification papers. These projects will involve the investigation taking place in a licensed laboratory facility and **NEVER** at home.
- Experimentation study of vertebrates is allowed, but in observation only and must be approved by your teacher and a licensed veterinarian. No physical harm to the animal is accepted. Please consider using invertebrates. All procedures for the care and maintenance of living things must be documented in your logbook. A mortality report (a count of the number of living things that died) must be included in the logbook.
- Always have safety and other types of procedures documented in your logbook and cite the resources where you found and/or studied them.
- Experimentation is **NOT** permitted to begin until **ALL** required student forms are submitted and approved.

You've Chosen a Project!!! Now What?

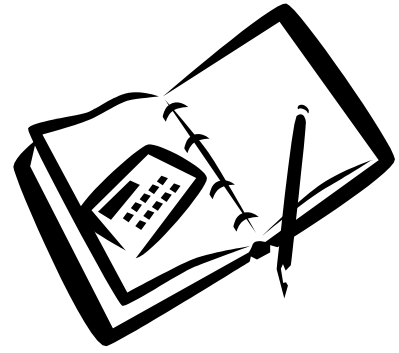
Complete this form. Now that you have chosen a project you need to be able to answer the following questions.

1. Which category will this project be entered in?
2. What is the title of this project?
3. What should be the topic of your research paper?
4. What is the specific question or problem to be investigated?
5. What is the manipulated (independent) variable in this experiment?
6. What is the responding (dependent) variable?
7. What factors will be held constant for this study?
8. What is the measurable outcome and what units will be used for measurement?
9. What is the hypothesis for this problem?
10. What materials will be needed to complete the experiment and where can those materials be obtained?
11. How will the experiment be designed?
12. Where will the experiment take place?
13. Who would be helpful to contact for information on this study?

Log Book

A project logbook is your most treasured piece of work. Accurate and detailed notes make a logical and winning project. Good notes show consistency and thoroughness to the judges.

1. Record everything that you do or need.
2. Use BLACK INK only. Not pencil or any other color of ink.
3. All pages (front and back) should be numbered in the lower outer corner.
4. No pages are to be torn out.
5. No liquid paper or white out.
6. If you need to change something, cross it out neatly, and write in the change. Crossed out values should still be visible.
7. Keep notes of interviews or phone calls, phone numbers and e-mail addresses if you are corresponding to or interviewing a professional in your field of study. Note e-mail replies or paste in printed copies if necessary.



Setup for Background Information in the Log Book

1. Record bibliography information at top of the page for the source that you will be using.
2. Record the day's date in margin at top of page.
3. Place number of page that you are referencing from in the margin.
4. Record EACH page used from text.
5. Write brief, bulleted notes NOT WHOLE PARAGRAPHS.
6. If notes continue onto the next page of log book, record date and page of text in margin.
7. When using Internet source, record notes in logbook – just like other reference. Use MLA for information needed.
8. Use NEW log page for EACH change of text.

~Sample Note Page~

8/29/03

Cosgrove, Brian. Weather. New York: Alfred A. Knoff, 1991.

Page 6

- The atmosphere is a blanket of gases surrounding the Earth.*
- The lowest layer of the atmosphere is the troposphere.*

Page 8

- The world around us gives clues to the weather.*
- People near the sea often hang out strands of kelp, for seaweed is one of the best natural weather forecasters.*
- Fine weather - kelp shrivels and is dry to touch.*
- Rain threatens - the weed swells and feels damp.*

Page 9

- Weather has been studied for centuries.*
- Study of weather is called meteorology.*
- Meteorology - began in Italy: 17th century.*
- Galileo Galilei made first thermometer.*

Keeping the Daily Journal

- Begin keeping a journal when you begin to organize your experiment.
- Note where materials were obtained.
- Record daily events and observation that are a part of Science Fair.
- Date each entry.
- Write the date in the margin using 6 digits. **Example: 10/02/03**
- If conducting many trials on one day, record the time for each trial. **Example: 10/02/03 @ 4:30pm**
- When experimentation is complete write the final entry, sign your name in cursive and date after your signature.
- Make qualitative AND quantitative observations.
- Use only metric measurements.
- Also record data in data table portion of logbook.

Sample Journal Page

10/02/10	Purchased soil and Lima Beans at Home Depot. Total cost \$3.50
10/03/10	Planted seeds according to Research Plan. Plants were placed set up on the porch with an east exposure. Each plant was watered to field capacity.
10/04/10	No growth noted.
10/05/10	No growth noted.
10/06/10	Control set up: 3 cm growth Set Up A: no growth Set Up B: no growth Watered to field capacity

How to Write a Bibliography

Books With One Author

Format:

Author's Last Name, First Name, Title. City of Publication, State (Abb.): Publisher, latest copyright date, page numbers.

Example:

Bond, Peter. The Firefly Guide to Space: A Photographic Journey through the Universe. Willowdale, ON: Firefly, 1999, pp. 45-49.

Book With More Than One Author

Example:

Bolman, Lee G., and Terrence E. Deal. Leading with Soul: An Uncommon Journey of Spirit. New and Rev. ed. San Francisco: Jossey-Bass, 2001. Pp 189-190.

Encyclopedia

If the encyclopedia is well known and articles are arranged alphabetically, it is not necessary to indicate the volume and page numbers.

Format:

Author (If known, last name first). "Title of Article." Encyclopedia Title. Edition. Date of publication if given.

Examples:

- *Article in encyclopedia with no author stated*

"Nazi Party." New Encyclopaedia Britannica. 1997 ed.

- *Article in an encyclopedia with author stated*

Kibby, Michael W. "Dyslexia." World Book Encyclopedia. 2000 ed.

Magazine Article

Format:

Author's last name(s)(if known). "Title of article." Title of Magazine, Date published: page numbers.

Examples:

- *Article in magazine, periodical with no author stated*

"100 Years of Dust and Glory." Popular Mechanics Sept. 2001: 70-75.

- *Article in magazine or periodical with author stated*

Hicks, Matt. "Scaling toward the Petabyte." eWeek 17 June 2002: 33.

Internet Resource

- *Online periodical*

Format:

Name of Author if given. "Name of article."Title. Date of publication,<online address>,date of access.

Examples:

"Beginner Tip: Presenting Your Page with Style." Webmaster Tips Newsletter. July 2000. NetMechanic. 12 Feb. 2001 <http://www.netmechanic.com/news/vol3/beginner_no7.htm>.

- *Online encyclopedia no author*

"Ho Chi Minh." Encyclopaedia Britannica. 1999-2000. Britannica.com Inc. 27 Nov. 2001 <<http://www.britannica.com>>.

How to Write a Bibliography (Continued)

Requirements

✓ The Regional and State rules require that the following entry be listed in your bibliography.

**"International Rules for Precollege Science Research." Intel ISEF 2008.
<societyforscience.org>.**

(Hint: If you are using Microsoft Word and need the second line of a bibliography entry to indent, go to format (on the toolbar)/paragraph/special- when the menu drops down at special click on hanging and then click on OK. The line will then indent for you.)

✓ The bibliography must have at least five total entries. The resource mentioned above does not count as one of the five resources. Have at least one Internet entry (other than the one mentioned above), at least one non-encyclopedia book entries, and three other entries of your choice (magazine, encyclopedia, etc...).

✓ Entries are listed in ALPHABETICAL order. Use the first letter of each entry to determine the order of the entries. Decide which entry will be second and so on.

✓ Your reference list should include any documentation that is not your own (*i.e.*, books, journal articles).

✓ It is especially important to reference any sources that provide safety procedures, disposal and/or housekeeping procedures that are valuable to your project.

✓ This website will help you construct your "Works Cited" Page"
<http://www.easybib.com/>.

Writing the Research Plan

The Research Plan is the foundation of your project. The Research Plan should be written so that another scientist could successfully reproduce your experiment. Please study carefully the pages that follow and use them as guides to properly develop your research plan.

1. Your final research plan must be identical to the sample of the lima bean experiment. The final copy should be typed in Arial or Times New Roman 12-point font. The format for the heading should be exactly as shown in the sample.
2. Write your TITLE with each word greater than three letters capitalized. This title must match the title of your project on the certification forms. Unless your title is a question it will not end in punctuation. The title you choose will be the title that appears on your display also.
3. The PROBLEM to be written as a question. Use the format, "What is the effect of "A" on "B"? Take care to use the words "affect" and "effect" appropriately. Use a question mark for punctuation.
4. The HYPOTHESIS is stated as an "if/then/because" statement. The hypothesis is an educated guess presuming the outcome of the experiment. After you have begun a background information review, you state the hypothesis as one possible outcome of the problem. The "if" part of the statement incorporates manipulated variable and the "then" part states what you suspect the response will be. The "because" statement is the reason you are making this guess based on your research about the problem.
5. MATERIALS lists everything used during the experiment including equipment, chemicals and organisms. Your list should be exact, including how much and what size. ALSO INCLUDE ALL SAFETY EQUIPMENT NECESSARY USE METRIC MEASUREMENTS ONLY. You may arrange ahead of time to borrow metric beakers, thermometers and other equipment from the lab or choose to come for an appointment to use lab equipment. DO NOT number materials sequentially.

Examples of Materials Lists:

Poor Listing

Measuring Cup
Water
Container
Thermometer

Good Listing

250 mL graduated beaker
750 mL distilled water
20 cm X 20 cm aluminum cake pan
Celsius thermometer

6. VARIABLES, CONSTANTS, AND CONTROLS lists the elements of your experiment that may effect the final outcome. The manipulated variable defines the aspect of the experiment that will change from trial to trial. The responding variable defines the aspect of the experiment that will be measured. Constants are aspects of the experiment that must not change from trial to trial. Remember only one aspect, or variable, may change from trial to trial to ensure that the experimental data is reliable. The control is the standard by which all experimental trials are compared.
7. Number your PROCEDURES in order of their occurrence. Be sure to list ALL of the steps of your experiment. IT IS IMPORTANT TO INCLUDE ALL SAFETY PROCAUTIONS NECESSARY. Include amounts and times if they were used. If steps will be duplicated you can state "Repeat steps 4 and 5." (example) Recording results is part of the procedure. Also, include in your bibliography the source of safety procedures that you may use.
8. A Materials Safety Data Sheet (MSDS) for each chemical used in a project must accompany the Research Plan.
9. Copies of tests /surveys given to subjects must accompany each Human Behavioral Project Research Plan.
10. Each Behavioral Project must have a "script" accompanying the Research Plan to assure consistency in subject testing.

Consider This... As You Develop Your Experimental Plan:

- When planning your experiment first develop a “test protocol,” listing all the necessary materials and steps including safety equipment and safety procedures.
- Run the experiment, keeping a logbook record of everything that happens in the “trial” or “protocol” experiment.
- If possible, run the experiment several times to refine your technique and determine its validity. Once you start recording consistent results, begin the actual collection of data to be used as experimental data.
- Be sure to use a control, when appropriate and to quantify all observations possible.
- Use your senses: tell what happened, what was seen, heard, smelled. Explain the changes that occurred and how those changes were determined.
- Measure carefully.
- Run the experiment as many times as possible. The number of plants, human subjects, or invertebrate animals in your sample and the amount of data collected determines the validity of your project. The judges place a great deal of consideration into the sample size and number of trials run.

Variables, Constants, and Controls

When testing your hypothesis, your test must be valid. There are many variables in an experiment. YOU MUST CHANGE ONLY ONE VARIABLE when stating your hypothesis.

- ✓ The *manipulated/ independent variable* is the one factor that you are going to change in your experiment.
- ✓ The *responding/ dependent variable* is the one factor that may or may not change because you changed the manipulated variable.
- ✓ The *constants* are all the factors that you will keep the same in each of your trials.
- ✓ The *control* in an experiment is the trial done without changing any of the original factors. It is the standard by which you compare your experimental trials.

EXAMPLE

Purpose: Does salt have an effect on the freezing rate of tap water?

Hypothesis: If salt is added to tap water, then the water will take longer to freeze because it lowers the freezing point of the water.

Manipulated Variable: The amount of salt added to the water.

Responding Variable: How long the water takes to freeze.

Constants: Amount of water in each container
Starting temperature of the water
Size and shape of the container
Material the containers are made from
Freezer used
Thermometer

Control Setup: The container in which no salt is added

Experimental Setup: Containers that hold varying amounts of salt.

McKeel Academy
Science Fair Research Plan: Form 1A #9

Name:

Period:

Category:

Project Title:

Problem:

Hypothesis:

Materials:

Manipulated Variable:

Responding Variable:

Constants:

Control:

Procedures:

McKeel Academy
Science Fair Research Plan: Form 1A #9

Name: X. Ample

Grade: 7

Category: Botany

Project Title: The Effect of Microwave Exposure on Lima Bean Growth

Problem: What is the effect of microwave exposure on the growth rate of Lima Bean seeds?

Hypothesis: If Lima Bean seeds are exposed to increasing amounts of microwave radiation then their growth rates will be affected negatively because microwave radiation is believed to damage the DNA of plants.

Materials: 3 Lima Bean Seeds 3 (4 cm x 4 cm x 6 cm) planting pots
450 g potting soil Microwave oven with second timer
Thermal glove Lab apron

Manipulated Variable: Experimental groups exposed to incremental increases in microwave radiation

Responding Variable: The growth of the lima bean plants in height and in mass over time (6 weeks)

Constants: All plants watered to field capacity once a week. The size of the pots and the amount of potting soil in each pot are the same. The relative locations and the amount of sunlight the lima bean plant are exposed to are the same.

Control: One group of plants comes from seeds that are not exposed to microwave radiation.

Procedures:

1. Put on lab apron.
2. Label the pots:
 - a. Control
 - b. 1 min
 - c. 2 min
3. Fill each of the planting pots with 150 g of potting soil.
4. Press one seed into the dirt of the control pot to a depth of .5 cm.
5. Place one seed in the microwave and turn on oven. Expose seed to microwave radiation for 1 minute.
6. Use thermal glove to remove the seed. Use caution because the seed will be hot.
7. Plant this seed in the pot labeled 1 min. at a depth of .5 cm.
8. Place the last bean seed in the microwave and microwave for 2 minutes.
9. Use thermal glove to remove the seed from the microwave. Use caution because the seed will be hot.
10. Plant seed 3 in the pot labeled 2 minutes at a depth of .5 cm.
11. Place these three pots near a window that receives direct sunlight.
12. Water to field capacity.
13. Record observations and measurements daily.

Metric and Customary Units

	Customary Unit	Metric Unit	Metric Unit Abbreviations
Units of Length	Inch Foot Yard Mile	millimeter centimeter decimeter meter kilometer	mm cm dm m km
Units of Volume/Capacity (derived units)	Fluid ounces Pints Quarts	milliliters liters	mL or ml or cc ³ l or L
Units of Weight/Mass	Ounce Pound Ton	milligram gram kilogram metric ton	mg g kg
Temperature	Degrees Fahrenheit	Degrees Celsius	° C

- ✓ **Science Fair rules require that only metric units be used for measurement in science fair projects**
- ✓ **Symbols for metric abbreviations are NOT capitalized** (with the exception of the “L” for liter, which can be capitalized but does not “have to be”)
- ✓ **Do not place a period after a metric abbreviation**
- ✓ **Conversion websites can be helpful. <http://www.worldwidemetric.com/metcal.htm>**

Tables and Graphs

Each experiment must have its data organized in a table and represented on a graph. A data table is a convenient way to store information as needed and organize information. A graph gives a quick visual display of results and projects and also serves as an organizational tool for data. It aids in comparisons so that conclusions may be drawn more readily.

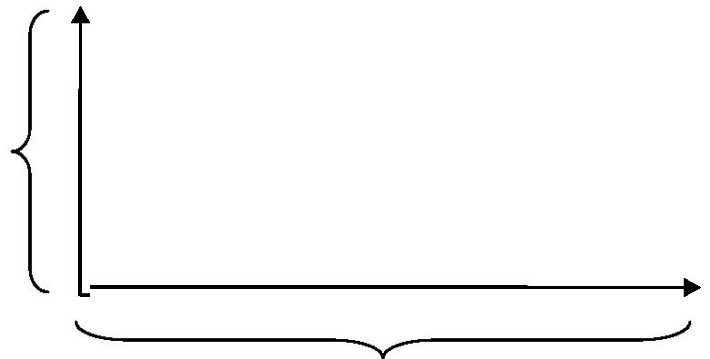
Data Tables

- Create a data table in your logbook to organize data collected during experimentation.
- Each project must have a data table in the log book and on the backboard.
- Title every data table.
- Design a data table appropriate for your project. Take care that each column and row has the proper heading.
- Include units of measurements in the headings NOT in each individual cell.
- Use a ruler to draw the data table in your log book.
- Use Microsoft Word or Excel to create your data table for your backboard. It must be computer generated.
- For more detailed instructions on how to prepare a data table, consult the appendix in your science text.

Graphs and Charts

- Determine which type of graph; bar, line or circle, would best illustrate your results.
- Title the graph
- For bar and line graph label the horizontal axis (x-axis) with the name of the manipulated (independent variable). Label the vertical axis (y-axis) with the name of the responding (dependent) variable. Use an appropriate scale on each axis.
- Graphs on backboard must be computer generated.
- See appendix of your science text for additional help.

Dependent or
Responding Variable is located on the
Y-axis



Manipulated or
Independent Variable is located on the
X-axis

Preparing Your Conclusion

You have done your experiment and organized your results in a table and on a graph. Your results reported what happened in your investigation. The conclusion is your analysis of these results. Tell what you learned from the trials and the testing. Compare the results with your original hypothesis. The results may establish your theory to be supported or not supported. It is also possible that the results will be inconclusive. The data may not be strong enough to prove or disprove your hypothesis.

LOOK FOR PATTERNS. Closely look at your data tables to see if a trend clearly emerges.

1. Did the data support your hypothesis or not? (Be honest – it's ok if things didn't turn out as expected)
2. What were the unexpected problems that might have affected the results of your experiment?
3. Did you make any mistakes and have to start over? If so, how would they have affected the outcome?
4. Did you gather enough data?
5. Did you do at least 3 trials?
6. How would you do your experiment differently the next time?
7. Is there some way you could expand your experiment in the future?
8. Who can use this information?
9. Why is this information important?

Writing the Conclusion

When you write your conclusion:

- Write in the **third person**
- Write in the **past tense** with the exception of the first sentence.

FIRST PARAGRAPH

- The first sentence should state whether or not your test results supported the hypothesis.

Example: It is concluded that the data collected supported the hypothesis.

It is concluded that the data collected did not support the hypothesis.

OR

The results of this project were inconclusive.

- The second sentence restates the hypothesis in a way that indicates whether it was supported or not.

Example: The data collected showed that the water in the black can got hotter faster than the water in the unpainted can.

- Add 2 or 3 sentences to the first paragraph stating what trends the results and data showed and how those results supported or did not support the hypothesis.

Example: The results also showed that the temperature of the black can remained an average of 2.5 degrees Celsius higher than the unpainted can. The data indicated that in this experiment the black can absorbed more of the sun's rays than the unpainted can.

SECOND PARAGRAPH

- In the second paragraph explain any problems or errors that may have affected the results of the experiment.

Example: This experiment was done during the latter part of December when the sun's rays are slanted the most since the sun is over the Tropic of Capricorn.

Some days during the experiment were cloudier than others and this affected the results. The thickness of the paint could have affected the results, also.

- Tell of additional experiments that can continue from your present one. Write at least 3 sentences in this paragraph.

Example: The next time the unpainted can should be painted with paint as close in color as possible to the original can color. This would eliminate a variable that was overlooked and test only the effects of the color of the cans. Also, it would be interesting to do this experiment during the summer solstice when the sun's rays are shining more directly on this part of the earth.

THIRD PARAGRAPH

- Write a third paragraph telling who could use this information.

Example: The information learned from this experiment would be helpful to home or commercial canners who want their products to remain as cool as possible after the canning process is completed. Roofing manufacturers could also use this information.

Certification Forms

Students participating in the McKeel Academy Science and Engineering Fair, Polk Regional Science and Engineering Fair and Florida State Science and Engineering Fair are required to adhere to ALL forms requirements set forth by the International Science and Engineering Fair Rules. CERTIFICATION FORMS MUST BE COMPLETED AND APPROVED BEFORE EXPERIMENTATION BEGINS.

What forms do you need? How do you complete the needed forms?

1. All necessary forms are found at the Florida State Science and Engineering Fair website: <http://www.floridassef.net/student/student-forms/>
2. If you have Adobe Acrobat installed as a program on your computer you can type directly on the ISEF forms.
3. Please use the "Rule's Wizard" provided by the ISEF site to determine which forms your project must have before experimentation begins.
4. Please note that each form has a number and they are referred to by the assigned number.
5. Please note that the forms are dated for the current year. You must use the current school year's forms.
6. All students must complete **Checklist for Adult Sponsor (1)**. **Your teacher's name** is considered the Adult Sponsor for each student. Please note that the appropriate boxes must be checked.
7. All students must complete **Research Plan (1A)**. (1) The student's name must appear as it will appear on all Science Fair related documents throughout the project. Include the grade level and an email address. (2) The Title of the Project **MUST** be as it will appear on the final backboard and abstract. This is mandatory. (3) enter the school information as follows:

McKeel Academy
1810 W. Parker Street
Lakeland, Florida 33815
(863) 648-3500

- (4) **Your teacher** is the Adult Sponsor. Enter the school phone number and your teacher's email .
- (5) Please contact your teacher if you are considering a continuation from previous year. (6) Your teacher will assign the date that experimentation begins and ends. (7) Check the appropriate work site and then (8) enter your home address for the first Work site option and any other place of study for the last Work site option. (9) Your completed research plan will be attached to Form 1A. Please see the Research Plan section of this handbook to complete research plan properly. (10) Abstracts will be written at the completion of the project and attached to this form. An abstract is **NOT** required when certification forms are due in September.
8. Please refer to the Research Plan Attachment section of your handbook that follows.
9. The **bibliography** can be added to Research Plan (1A) when the research paper is due.

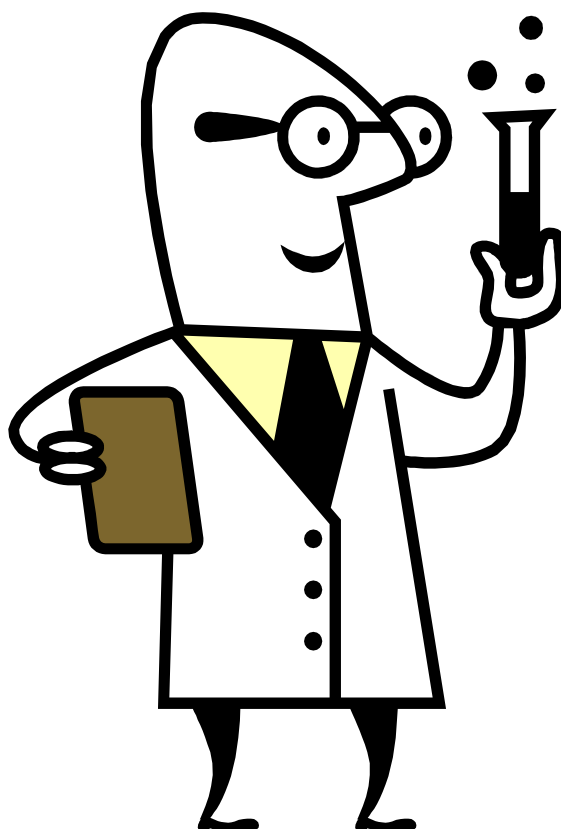
10. All projects must have a completed Approval Form (1B). Please note parents and student must sign AND date step 1. Steps 2a and b are completed by the Science Fair review committee. Step 3 is left alone at this time.

11. Other forms may be needed for completion of your project. Please read each line carefully to determine what information is needed and who needs to sign the form to validate it. **If other forms are needed (study requirements and use Rules Wizard) they must be completed and turned in on certification due date.**

ANY STUDENT USING HUMAN SUBJECTS

You must have Form 4 completed to be approved by the review committee. After your project has been approved by, you will take this form and have it copied a number of times. **Then you will have *EACH SUBJECT* sign a copy of the form AND date it before they participate in your experiment. If your subject is younger than 18 you must also have their parents sign the form.**

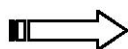
SAFETY FIRST ALWAYS!!!!



Abstract

The abstract is a summary of your project. It will include the following information in this order:

- A statement of purpose
- A statement of the hypothesis
- A shortened version of the procedure (NOT in step by step detail)
- The conclusion reached through analyzing the results



THIS IS THE JUDGES' FIRST IMPRESSION OF YOUR PROJECT.

- The abstract is extremely important to your project. The judges receive a copy of your abstract before the fair so they can review the projects that they will be judging.
- It is part of the entry form for the McKeel Academy fair, the Regional fair and the State Fair.
- It must be prepared on the official Florida State Science and Engineering Fair form that can be found on the <http://www.floridassef.net> website. This form needs to be completed according to the instructions below:
 1. Give your project title. Capitalize the first letter of each word that is greater than two letters.
 2. The title given must be the title on your backboard.
 3. The entire abstract must fit within the box on the form.
 4. Type single-spaced using Times New Roman font and a 10 or 12 pt. font size.
 5. The abstract is approximately 200-250 words.
 6. Complete the questions at the bottom of the abstract.
 7. Sign and date the completed form.
- Please have your abstract edited by a responsible adult or classmate to insure that it makes sense and is free of spelling and grammatical errors.
- Print 10 total copies. Please furnish **8** original, signed copies to your teacher. Place an original, signed copy on your backboard. Keep one copy for your records.
- Save your abstract on your hard drive or other form of storage on your computer.
- Your abstract will be placed in the lower left corner of your backboard. You will need to produce this copy. Your teacher will not have one to give you.

Backboard

The purpose of your display is to present your project to the judge and the public. Content, or the information on the board, is important. Science Fair display boards have a 3-panel configuration and the traditional way to setup this type of board is:

Problem	Title of Project	Variables, Constants & Control
Hypothesis	Illustrations/Photos Tables/Graphs	Materials
Abstract	Charts	Procedures Conclusion

Your display represents you. Give it your best effort!

- Label each part of your display as shown. Type large enough for the viewer to read easily.
- **SPELLING MUST BE CORRECT**
- Back your information with construction paper.
- It is good to use complementary colors in your display.
- ***Use rubber cement, glue stick or double-faced tape to mount your paper to the backboard. No tacks or staples!***
- Use a paper cutter rather than scissors for a neat display.
- Photographs make an excellent display.
- All photographs, graphs and tables must be labeled. Photos must include a caption explaining the images and credit must be given to the person who took the picture. Graphs and tables must include a proper heading and if the data was taken from a source other than your logbook, credit must be given to the originator of that data.
- No embellishments may be added to the board (nothing may be attached) for simply decoration purposes. See your teacher if there is a question.

Old Granddaddy use to say, "Plan your work and work your plan!" That is an important idea to remember when putting the backboard together. Try to make your display look balanced. Before you begin, make sure you plan out your board including making sketches. Planning your work can help save you the money of purchasing additional boards.

Exhibit Requirements

- A freestanding, durable backboard must be used for the display.
- **Maximum size** for an exhibit is:

76 cm (30 in.) deep, front to back

122 cm (48 in.) wide, side to side (**outside to outside**)

274 cm (108 in.) high, **floor** to top of exhibit

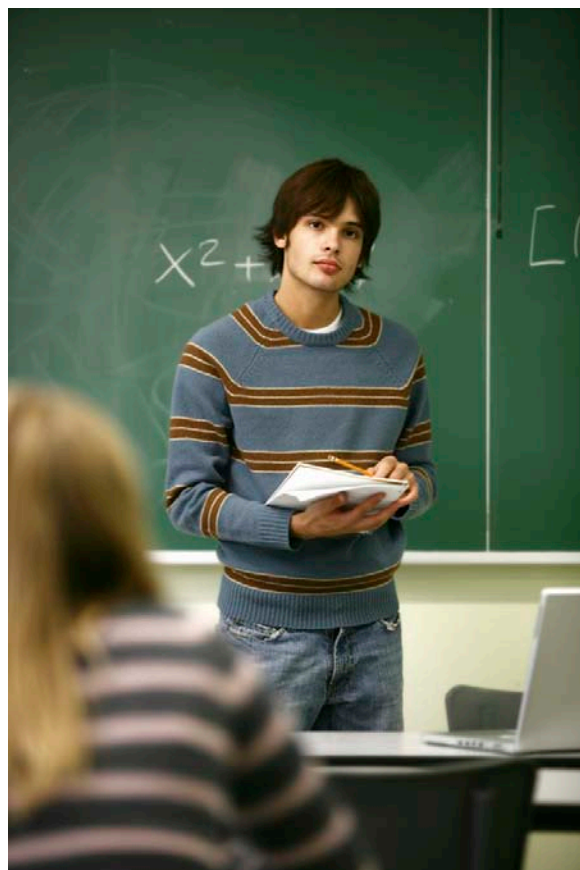
A standard table is about 30 in. high

- A copy of the abstract **MUST** be displayed with the project, in the lower left corner. The abstract must be in the format presented in class.
- The student's log (Composition Notebook) **MUST** be on display along with the backboard for judging.
- Although "props" will not be allowed at the Regional Fair, they will be allowed at the McKeel Academy fair. Props help the students to better describe their project to the judges. All props and other papers not attached to the backboard are to be taken home after the judging is complete. Life animals, microbiology cultures chemicals for display purposes and use of electricity will not be permitted as props.

Planning the Oral Presentation

The oral presentation for the judges is an important part of your project. Practice will make the difference in how well you can present yourself. Rehearse in front of a mirror, and then later make a practice presentation before a “live” audience – a friend or someone else who will listen attentively.

1. Display Good Manners: Stand up straight to the side of the exhibit; look listener in the eye; be polite and **SMILE** 😊.
2. Make introductions. Be sure to speak audibly. First, introduce yourself. “*Hello. My name is _____.*” Next, introduce the project. “*The title of my project is _____.*” Then, introduce the purpose. “*The purpose of my project is _____.*” Finally introduce your procedure. “*The procedure I followed was _____.*”
3. Identify your control set up and your experimental set up. Discuss your manipulated or independent variable and your responding or dependent variable. Use these terms and the vocabulary about your topic that you learned as you prepared your Research Paper.
4. Show your results. Point out your log, table and graphs and explain each.
5. Explain your conclusion. If you feel that you had some problems with experimentation, don't be afraid to talk about them. Even the best scientists have to overcome obstacles along the road to discovery.
6. Discuss what you learned. Tell what you discovered about the topic or about the scientific process itself. Explain what you would do differently if you were to repeat this experiment or conduct another.
7. Invite questions. Ask the audience if they have any questions or items they would like explained further.
8. Say **THANK YOU!** Don't forget to thank your listeners for their attention and interest.

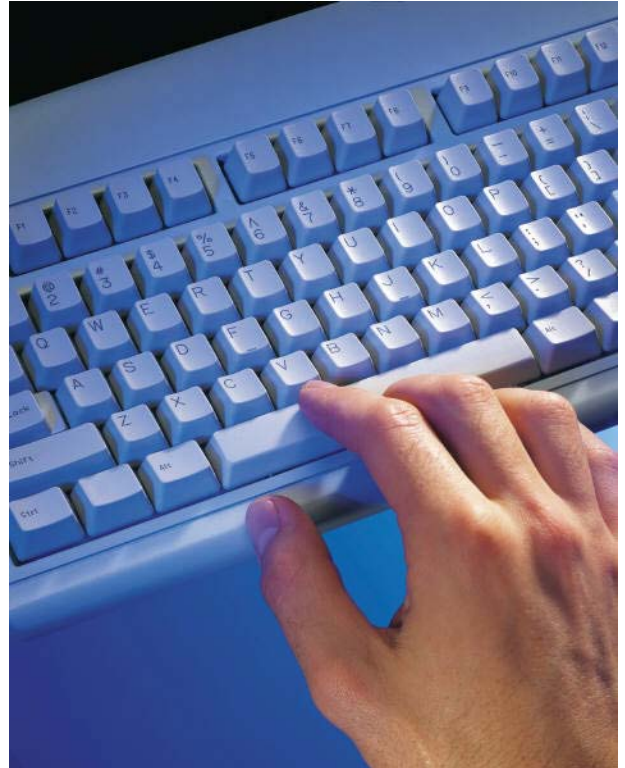


Science Fair Research Paper

Please use the following as a preparation guide.

- Gather background information for the paper and write notes in your logbook.
- Organize your paper using a graphic organizer (writing web)
- Use Times New Roman, 12 pt. Font.
- Black ink only
- Paper must be at least three fully type-written 8 ½ -by-11-inch pages
- The research paper must have a correctly completed 4-line heading on the first page in the center. The heading should follow the format below.

Student Name
Teacher Name/ School
Category Entered
Due Date of Research Paper



- Margins are to be one inch at the top and bottom and on both sides of the text.
- The research paper must be double-spaced throughout.
- Use a running head in the upper left corner of each page that includes your last name followed by the page number.
- The title of the research paper must be centered just above the text. Do not italicize, underline, or place the title in boldface type.
- Have a good editor review and edit your rough draft for spelling and grammatical errors.
- Do not use subheadings throughout the science fair research paper.
- The research paper is written in **third person** (do not use pronouns such as "I", "me" or "my").

SAMPLE RESEARCH PAPER

The Effect of Different Genres of Music on the Health and Growth of Poinsettias

Eddie Ross
Mr. Mark Jones/ McKeel Academy
Botany
January 15, 2011

TABLE OF CONTENTS

Section	Page Number
Introduction	1
Materials and Methods	2
Results	4
Discussion	7
Conclusion	9
Acknowledgements	9
Works Cited	10

The purpose of this project was to find the effects of different genres of music on the health and growth of poinsettias. It has been believed by many people for a long time that talking to plants may stimulate growth. Is it not then a valid assumption that music, with its varying degrees of vibration, may stimulate or hinder the health and growth of plants? This experiment will put this assumption to the test.

It was hypothesized that if different groups of poinsettias were exposed to different genres of music separated by varying degrees of vibration for a continuous period of time, then the plants exposed to classical music would display the most growth and show evidence of higher degrees of health. The reason for this hypothesis is that the researcher believes that soothing vibrations from classical music will better stimulate cell growth than the other genres of music to which the plants will be exposed. In fact, the researcher also believes that genres of music with more distorted vibrations will have the opposite effect on the plants. The plants exposed to rap music and heavy metal should show deteriorating health and stunted growth.

As a musician, I enjoy many forms of music. It is interesting to see the effects that different genres of music have on people. Different genres of music elicit different emotional responses from the listeners. At rock concerts, people in the crowd jump up and cheer in excitement due to the raw energy and power of the music. At the opera, people close their eyes and show high relaxation in their facial expressions. Others, demonstrate a high emotional response through tears at a point when the music crescendos into its most glorious point. What prompted this research was a related question that the researcher asked when listening to music while watering plants one day. "If plants do not demonstrate emotion, could they manifest a response to music through their growth and health?" The researcher believes that many of the "wives tales" taught about talking or playing music to plants may have some truth.

The researcher collected the following materials to test the hypothesis.

- 20 Poinsettia plants with the same approximate biomass of around 700 grams
- One Metric Triple-beam Balance
- Three compilation music CD's (Heavy Metal, Rap, and Classical)
- Three Phillips CD Players (Model AZ1109)
- One Metric stick
- Gardener's gloves

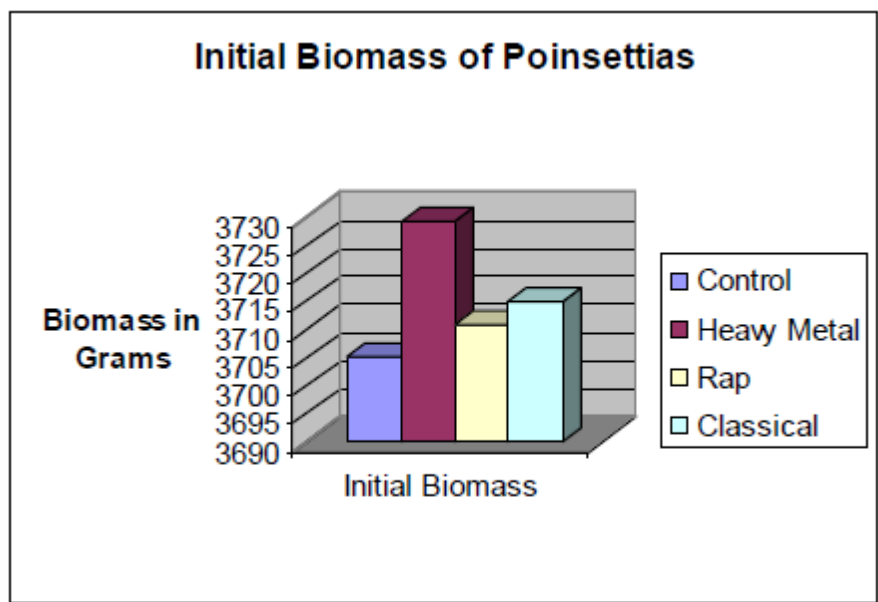
All poinsettias were purchased from the same location to ensure that the container size, type of soil, and age of plant were relatively constant. The researcher measured the biomass of each individual plant before the beginning of the experiment. This was done by removing each poinsettia from its container, shaking off as much excess soil as possible, and measuring the mass using a triple beam balance. The plants were then replanted in each container with its original soil.

The researcher placed the plants into four groups and assigned a letter and number for each plant. Plants placed in the "Control" group were assigned the letter "A" and each plant was numbered from one to five. These plants were placed in an isolated location with ample sunlight and were not exposed to any genre of music at any point of this experiment.

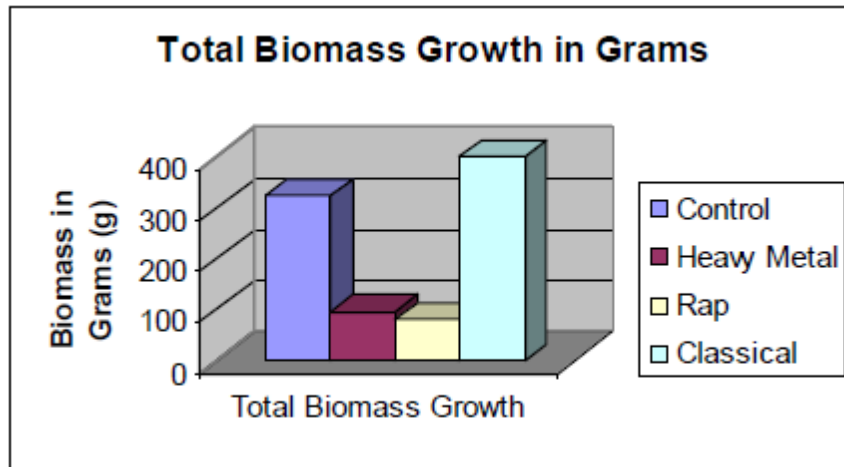
The three experimental groups of plants were assigned a different letter each and numbered from one to five. The plants exposed to Heavy Metal were assigned letter "B". The plants exposed to Rap were assigned letter "C". The plants exposed to Classical music were assigned letter "D". Each experimental group was placed in a separate, isolated location with ample sunlight. At each location, the CD players were placed at identical distances of one meter away from the groups of plants. The volumes of the CD players were set at "3" at each location to ensure that the volume of the music would not be an uncontrolled variable. The music was played continuously for a period of six weeks for each experimental group. To do this, the replay function of the CD player was set.

All plants were handled in the same manner with the exception of the genres of music. Each plant was properly watered to field capacity, meaning that enough water was given to the plant to soak to the bottom of the container. This was done every three days. The researcher wore gardener's gloves when handling the plants. Total biomass of each plant was measured only at the experiments conclusion to ensure that the health of each plant was not jeopardized during the experiment. However, the growth of the plant's total height was also measured through the duration of the experiment every week. The quantitative data collected by the researcher included the total biomass after the end of the experimentation period and measurements of the total height of the plants each week of testing. The biomass was measured in the same manner as before the experiment began. The height of each plant was measured by using a meter stick from the base of the soil to the longest point of growth. Qualitative data collected by the researcher included the color analysis of the leaves and stem. This was done to assess the healthiness of each plant.

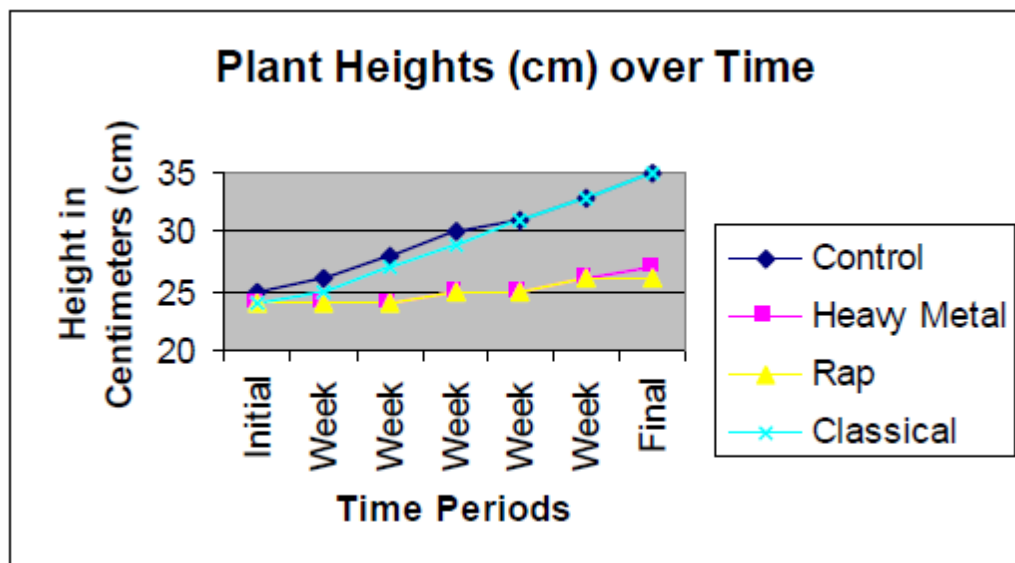
At the beginning of the experiment, each poinsettia's biomass was measured. The average poinsettia had a biomass of 743 g. The deviation of the highest and lowest biomasses was only 24 g. To ensure that initial biomass would not be an uncontrolled variable, plants were initially placed into their groups of five by adding together biomasses that were about equal in each group. The "Control" group "A" had an initial total biomass of 3705 g. Heavy Metal Group "B" had a total biomass of 3729 g. Rap Group "C" had a total biomass of 3711 g. Classical music Group "D" has a total initial biomass of 3715 g.



After the experimentation, the "Control" group "A" had a total biomass of 4030 g. This reflects an increase in biomass by 325 g. Heavy Metal Group "B" had a total biomass of 3825 g. This reflects an increase in biomass of 96 g. Rap Group "C" had a total biomass of 3792 g. This reflects an increase in biomass of 81 g. Classical music Group "D" has a total biomass of 4115 g. This reflects an increase of 400g.



Over the course of the experiment, the heights of each plant were measured. The average height of each experimental group and the control group were also taken after the experimental period ended. The average height of the “Control” group “A” was 35 cm. This reflected an average growth of 10 cm since the initial average height was 25 cm. The initial height for the Heavy Metal group “B” was 24 cm. The total average height after experimentation was 27 cm. This reflected average growth of 3 cm. The initial height for the Rap group “C” was 24 cm. The total average height after experimentation was 26 cm. This reflected average growth of 2 cm. The initial height for the Classical music group “D” was 24 cm. The total average height after experimentation was 35 cm. This reflected average growth of 11 cm.



In addition, each plant group was assessed for health by observing the colors and conditions of its leaves and stems. The “Control” group “A” displayed normal growth throughout the duration of the experiment. The colors were a vibrant red and the stems were flexible and strong. The Classical music group of plants “D” also displayed vibrant colors and firmness as well as the healthy growth. The Heavy Metal “B” and Rap “C” groups of plants had drooping stems and faded and decaying leaves by the end of the experiment as seen below.



Poinsettia from Control Group on 11/02/10

Poinsettias (*Euphorbia pulcherrima*) are commonly referred to as “the Christmas Plant” (McMahon). These plants are short and have bright red or yellow leaves. Poinsettias are believed to have originated in Southern Mexico and were introduced to the United States in 1825 (McMahon). According to fernlea.com, it is recommended that poinsettias be grown in indirect sunlight for at least six hours per day. In addition, they should be kept at a temperature between 68 to 70 degrees Fahrenheit (fernlea.com). During the experiment, the poinsettias in the control group may have received too much direct sunlight. The researcher believes that this was an uncontrolled variable but did not affect the overall results of the experiment.

Though there has not been much research on the effects of music on poinsettias, there has been a history of research on how plants in general are affected by music. According to Don Robertson at dovesong.com, “In 1973, a woman named Dorothy Rettallack published a small book called *The Sound of Music and Plants*. Her book detailed experiments that she had been conducting at the Colorado Woman’s College in Denver using the school’s three Biotronic Control Chambers. Mrs. Rettallack placed plants in each chamber and speakers through which she played sounds and particular styles of music. She watched the plants and recorded their progress daily. She was astounded at what she discovered.” Robertson goes on to outline experiments done by Rettallack that showed that chaotic music such as Hard Rock harmed plants while music with soothing tones stimulated growth and health (Robertson).

According to Doorne,” Certain sounds and even some kinds of music can influence plant growth in different ways. A lot of ancestral stories testify the role of music on plants and even much recent research. One way is that *certain sound frequencies could possibly activate certain genes* in cells and so influence the growth and expression of the cells. A second way is that *sound frequencies resonate with objects*. With every object a resonant sound frequency can be found and calculate so that when playing that sound the object would resonate. Resonant mechanisms can have profound impacts like glasses that break, even on plants we can found resonant mechanisms” (Doorne). This is the premise that the researcher is supporting, that musical tones can influence cell growth.

Other research suggests that music has no effect on the health of plants. “The idea that music can be used to stimulate cell growth in plants is an errant one. It is more plausible to suggest that those who attempt to conduct such research contribute to a self-fulfilling prophecy about the outcomes. In other words, those who hold to this argument probably, without ill-will, unintentionally alter the outcomes due to their plant care practices (Phinneas, 33). For this reason, the researcher employed methods that would not unintentionally sway the outcome. Plant care practices were consistent throughout the course of the experiment.

In conclusion, the hypothesis that if different groups of poinsettia plants were exposed to different genres of music for a continuous period of time, then the plants exposed to classical music would display the most growth and show evidence of higher degrees of health was supported. Poinsettias exposed to classical music grew the most and had the healthiest appearance when compared to the control. This group of plants grew an average of 10.8%. The control group of plants not exposed to music at all grew an average of 8.8%. The poinsettias exposed to the more chaotic music (heavy metal and rap) displayed both poor growth and unhealthy appearance when compared to the control. The group of plants exposed to heavy metal music only grew an average of 2.6% while those exposed to rap music grew only an average of 2.2%.

Few unexpected events may have influenced the results of this experiment. The plants, at most times, were given equal amounts of sunlight with the exception of the control group of plants which may have received too much sunlight during the first few days of experimentation. Also, a small ant infestation was observed with the Heavy Metal group "B" of plants. The infestation was small and is not believed to have damaged the poinsettias in that group.

Practical applications for the knowledge attained from this project includes the possibility of devising horticultural techniques utilizing music in small hydroponic labs or indoor nurseries that have the capability to be equipped with sound systems. It is not practical to employ such methods on larger scales such as a farm since the size is vast and the cost to utilize these techniques would outweigh the benefits. In addition, the common gardener may utilize playing soothing music while gardening not only to benefit the plants, but to enjoy.

The researcher acknowledges and thanks Mr. Barney Greenthumb for providing the locations to house the plants as well as the electrical resources for the music at his greenhouse.

Bibliography

Doorne, Yannick Van. Accessed 24 Nov. 2007.

<<http://users.belgacom.net/gc681999/Onderwerpen/Info/Ecosonic.htm>>

Fernlea Flowers. Poinsettia Care Information. 2005. accessed 25 Nov 2007.

<<http://www.fernlea.com/xmas/poininfo.htm>>

International Rules for Precollege Science Research. Intel ISEF 2007. www.societyfoscience.org.

McMahon, Peg. Poinsettia Care in the Home. 2007. Ohio State University Extension Fact Sheet. 25 Nov. 2007. <<http://ohioline.osu.edu/hyg-fact/1000/1248.html>>

Phinneas, Robert. Botanical Myths: A Muddled History. Chicago: Boris Books, 2002.

Robertson, Don. About Positive Music. May 2005. The Text Library. 25 Nov. 2007.

<http://www.dovesong.com/positive_music/plant_experiments.asp>

Logbook Grading Rubric

Student Name: _____ Period: _____ Date Checked: _____

Section	Max. Pts	Score
Planning Calendar	5	
Choosing a Topic	5	
Daily Journal	15	
Background Information	15	
Problem and Hypothesis	10	
Designing the Experiment	10	
Materials and Procedures	10	
Data	15	
Results and Interpretation	5	
Conclusion	10	
Total Possible =	100	

Backboard Rubric

Name: _____

As instructed in Science Fair Handbook

Title	Possible	Earned
Properly Stated Spelling Correct Punctuation Correct	10	_____
Hypothesis Written as an If/Then statement Properly Stated to define experiment	10	_____
Materials Safety Equipment noted if needed Quantities of materials needed are listed Size of Materials needed are listed if needed Appropriate Metric Measurement used	15	_____
Procedures Safety precautions noted Numbered in order of occurrence Procedures are reproducible	20	_____
Abstract Written on IFES form Written according to handbook instructions	10	_____
Data Table Title on Data table Appropriate units used	10	_____
Graph Computer Generated Graph titled Appropriate graph used Axis are labeled appropriately All necessary information needed is given	10	_____
Conclusion Written in the third person Written in past tense Appropriate language used First paragraph relates test results to hypothesis Second Paragraph +problems/errors and tells of additional experiments Third paragraph = appropriate applications for the project.	15	_____
	TOTAL	_____/100

Science Fair Presentation Rubric

Score: _____

Student: _____

Project Title: _____

Project Category: _____

	Max # Points	Score	Guidelines
Problem & Hypothesis	10		Is problem understood, well-written and novel/new/important? Is it written as a question? Is the hypothesis well-written as if/then statement and completely testable? Does evaluation of the hypothesis shed important light on the stated problem?
Variables & Controls	10		Are the manipulated and responding variables clearly defined? Are controls well-chosen and appropriate? Are any important variables not controlled?
Exp. Design & Procedures	15		Is experiment well-designed, complete and quantitative? Does it address the hypothesis? Are procedures described clearly and completely? Are metric units used appropriately? Are the design and procedures well-documented in the logbook?
Materials & Equipment	5		Are they carefully identified and appropriately used?
Data Collection	15		Was a sufficient amount of data collected? Is it appropriately quantitative? Does the collection process minimize uncertainties? Are the data recorded in the logbook in a well-organized fashion?
Data Analysis	15		Was the analysis appropriate and correct? Does it include an error analysis? Has the data been appropriately graphed? Does the graph aid in understanding the results?
Results & Conclusions	10		Are the results and conclusions clearly identified and correct (given the data)? Are all significant features of the data identified? Do the results address the hypothesis?
Visual Display	10		Without reference to the quality of the information, is the display clear and visually appealing? Are good writing skills demonstrated?
Oral Presentation	5		Was the student's oral presentation clear and concise? Did the student display a good understanding of the project and related background information? Did they handle questions well?
Applications	5		Has the student identified practical applications associated with the problem selected? Are they clearly described and related to the hypothesis selected?

Science Fair Research Paper Rubric

CATEGORY	10-7	6-4	3-1	0
Title	Title present.			No title.
Question/Purpose	The purpose of the lab or the question to be answered during the lab is clearly identified and stated.	The purpose of the lab or the question to be answered during the lab is identified, but is stated in a somewhat unclear manner.	The purpose of the lab or the question to be answered during the lab is partially identified, and is stated in a somewhat unclear manner.	The purpose of the lab or the question to be answered during the lab is erroneous or irrelevant.
Experimental Hypothesis	Hypothesized relationship between the variables and the predicted results is clear and reasonable based on what has been studied.	Hypothesized relationship between the variables and the predicted results is reasonable based on general knowledge and observations.	Hypothesized relationship between the variables and the predicted results has been stated, but appears to be based on flawed logic.	No hypothesis has been stated.
Materials	All materials and setup used in the experiment are clearly and accurately described.	Almost all materials and the setup used in the experiment are clearly and accurately described.	Most of the materials and the setup used in the experiment are accurately described.	Many materials are described inaccurately OR are not described at all.
Procedures	Procedures are listed in clear steps. Each step is numbered and is a complete sentence.	Procedures are listed in a logical order, but steps are not numbered and/or are not in complete sentences.	Procedures are listed but are not in a logical order or are difficult to follow.	Procedures do not accurately list the steps of the experiment.
Variables, Constants and Control	All elements are clearly defined and present.	Almost all elements are presents and/or clearly defined.	Most of the elements are present and./or clearly defined.	Many elements missing and/or not defined.
Data	Professional looking and accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.	Accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.	Accurate representation of the data in written form, but no graphs or tables are presented.	Data are not shown OR are inaccurate.
Analysis	The relationship between the variables is discussed and trends/patterns logically analyzed. Predictions are made about what might happen if part of the lab were changed or how the experimental design could be changed.	The relationship between the variables is discussed and trends/patterns logically analyzed.	The relationship between the variables is discussed but no patterns, trends or predictions are made based on the data.	The relationship between the variables is not discussed.
Conclusion	Conclusion includes whether the findings supported the hypothesis, possible sources of error, and what was learned from the experiment.	Conclusion includes whether the findings supported the hypothesis and what was learned from the experiment.	Conclusion includes what was learned from the experiment.	No conclusion was included in the report OR shows little effort and reflection.
Background Sources	Five reputable background sources were used and cited correctly. Material is translated into student's own words. The ISEF website is also included.	A few reputable background sources are used and cited correctly. Material is translated into student's own words.	A few background sources are used and cited correctly, but some are not reputable sources. Material is translated into student's own words.	Material is directly copied rather than put into students own words and/or background sources are cited incorrectly.