**Magnet Biology: Research Experiment Project Information**

This is a semester-long project, with 12 different parts due at various times throughout the semester. DO NOT LOSE THIS TIMELINE as it contains all important due dates for this semester. Write these dates into your planning calendar. The students of Wheeler High School have established a tradition for excellence in science; therefore, your research project is expected to be thorough, thoughtful, and detailed.

The Research Project consists of the following components:
**1. Approved research plan.**  In it, you describe exactly how you are going to do your experiment. The research plan includes a permission form which must be signed by your parents and your teacher before you are allowed to start your project. You have four weeks now to write your plan.

**2. Logbook:** A logbook is a diary of everything you do related to your science project. Keep track of what you did on what dates. Write all library research notes, background information you collect from books, magazines, online services, and people you consulted with. Write all bibliographic information in the logbook (Titles of books and magazines, author, pages, websites). Make sure you write your research procedure in your logbook. Composition notebook is highly recommended.
 **3. Draft** (rough) versions and a final copy of a science paper, typed exactly in the format of one of your laboratory reports. This needs to be typed in Times New Roman 12 point font, double-spaced, APA format.

**4. Poster Board/ Trifold.** This is a self-standing display to be entered in the school science fair.   The display includes a poster presentation of the experiment together with the items above. We use display rules of the International Science and Engineering Fair (ISEF).

**5. Art Data.** In this STEAM-certified program, Wheeler students learn the skills to display their data in not only graphic forms, but in more visually appealing artistic forms. More information on this will be provided towards the end of the semester.

**6.** An **oral presentation** describing your project. Oral presentations begin **December 12th or 13th**
**7.** If selected, you will take your project to the Cobb/Paulding Regional **Science Fair**.

All of the project requirements will be discussed in class, and we will go to the media center for a research and APA format tutorial. This is an independent project and you are expected to be SELF MOTIVATED.

This challenging assignment will give you an opportunity to demonstrate your abilities and determination. You will have an opportunity to earn recognition and numerous awards, both monetary and symbolic. But most of all, you will have an opportunity to direct your own research project, and to learn something that interests you personally.

Carpe diem!

Seize the Day! Achievements on this independent research project can have major payoffs for you later.

**Magnet Biology Research Project Timeline**

**August 28 – TOPIC MUST BE SELECTED.** (10 points)

Turn in your idea for an experiment involving living things (\*See the “First Objective” sheet for requirements and some ideas). This should include a title, hypothesis, and at least some information about HOW you plan to do the experiment. One paragraph is expected. See the “First Objective” sheet for some ideas.

**September 11 – RESEARCH PLAN DUE.** (10 points)

Provide a much more detailed written explanation of the project. Your explanation should include the following (and may be listed in numerical format as below if you like):

1. The title of your project
2. Your hypothesis
3. A definition or description of things involved in your experiment. Also tell how long you expect your experiment to last.
4. A description of the equipment and materials you’ll be using
5. Details about WHAT you’re going to measure and HOW OFTEN. Also tell exactly HOW you will do the measuring.
6. A description of your control group and your experimental group. It is ok to have more than one experimental group, if needed.
7. How many individuals (replicates) will be in each group. Generally, studying fewer than 30 individuals is unacceptable.
8. Use the posted rubric to help you as you create your research plan!

**September 18 – ALL FORMS DUE (link on blog).** **\*DO NOT START YOUR EXPERIMENT UNTIL ALL FORMS ARE SIGNED!\*** (10 PTS). Print, sign and give these forms to Mrs. Phillips for review BEFORE beginning experiment.

**October 18 – TURN IN YOUR RESEARCH PAPER – 700-1000 words.**  (20 points)

The paper will become the Introduction part of your final written report. Refer to the rubric and other instructions discussed in class to make sure you are researching, writing, and formatting this paper correctly.

**October 27 – LOGBOOK CHECK AND PHOTOS.** (10 points)

By this time you should have a large amount of information written into your logbook, including DATA that you have collected during your experiment. BRING YOUR LOGBOOK TO CLASS WITH YOU. Also, you must print and paste in your logbook at least ONE photo of your experiment.

**November 7 – MATERIALS AND METHODS PAPER DUE TODAY.** (10 points)

Follow the instructions and/or rubric as discussed in class.

**November 17 – LOGBOOK CHECK** (10 points)

**November 28 – TURN IN RESULTS** (10 points)

This includes charts, graphs, text and statistics as desired and/or required. Must be computer generated.

**December 4 – DISCUSSION** (10 points)

Turn in your discussion section, following rubric/instructions as discussed in class.

 All of the above = 100 pts

**Final Project Items:** display board, art data, final paper, logbook, presentation All together = 100 pts

**December 12 – TURN IN YOUR FINAL RESEARCH REPORT.** PRINT A FINAL COPY FROM HOME OR MEDIA CENTER BEFORE COMING TO CLASS. This will be a cohesive lab report that includes all prior submissions. HOWEVER, YOU MAY NOT USE THE HARD COPIES I HAVE ON FILE FROM PRIOR DUE DATE SUBMISSIONS.

**December 13 –** **TURN IN DISPLAY BOARD, LOGBOOK, and ART DATA. ORAL PRESENTATIONS BEGIN.**

**Research Project Rubric: Research Paper**

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| **Research Plan (10 points total)**  |
| 1 | Title of project is descriptive and lets the reader know exactly what will be measured. |  |
| 1 | Hypothesis is written clearly and is measurable. |  |
| 4 | Description of experiment and equipment involved is brief but clear. |  |
| 4 | The experiment’s variables are controlled appropriately as to produce valid data. Description of control group and experimental group. Details about what you’re measuring and how often. How you will do the measuring is described. There are an adequate number of data points. |  |

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| **Research Paper (20 points total)**  |
| 4 | Background information on independent and dependent variables are thorough. |  |
| 4 | Review of prior research is thorough and relevant. |  |
| 4 | Statement of problem/hypothesis. How does this experiment fit into the existing body and how is it unique? |  |
| 4 | Significance. What is the purpose of this experiment? How is it relevant and/or how will the data help science or society? |  |
| 2 | In-text citations, references page, and title page are all in correct APA format |  |
| 2 | Paper is well-written, with logical organization, effective transitions, clear sentence and paragraph structure, and minimal grammar or spelling mistakes. |  |

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| **Materials and Methods (10 points total)** |
| 5 | Clear, precise description of methods. This section should document the procedure in a way that will allow anyone to replicate what was done. |  |
| 3 | Methods clearly address the experiment’s purpose. The variables are controlled appropriately. |  |
| 1 | Written in paragraph format. Past tense, objective, and utilize passive voice. |  |
| 1 | Paper is well-written, with logical organization and minimal grammar mistakes. |  |

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| **Data and Results (10 points total)** |
| 2 | Results in paragraph form. Do not discuss what the data means here, simply report what the data is. All relevant data is stated in appropriate detail.  |  |
| 2 | Data tables and graphs. Each item has a descriptive title and sequential number as in APA format. Data tables and graphs are formatted clearly, with appropriate axes labels, legends, etc. |  |
| 2 | Description of data tables and graphs. Any item shown should be described in writing. Summary values from figures and tables should be described and highlighted. |  |
| 2 | Statistical Test. Test chosen is appropriate and answers the research question. |  |
| 2 | Paper is well-written, with logical organization and minimal grammar mistakes. |  |

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| **Discussion and Conclusions (20 points total)** |
| 2 | Major findings. Describe the meaning of the results (analyze the data). |  |
| 2 | Support of hypothesis by data and comparison to other research. Which data in this experiment supports or refutes the hypothesis? Do these results align with previous studies? |  |
| 2 | Explanation for findings. Why did they turn out this way? What errors occurred or what critical steps created this result? |  |
| 2 | Recommendations or improvements for future experiments. What should be done/improved if this experiment were to be repeated? What further studies could extend upon this experiment? |  |
| 2 | Paper is well-written, with logical organization and minimal grammar mistakes. |  |

**How to Write a Lab Report**

* ***FONT AND SIZE?*** ***PURDUE SITE FOR REFERENCE?*** Title - Place the title at the top, center of page 1. \**See the example at the end of this document*.

The title must be descriptive - it must give the reader a good idea of what topics will be covered.  “Bean Experiments” is a very bad title; all the potential reader knows is that the scientist did experiments with beans.
 A better title might be “The Effect of Phosphorus Fertilizers on Seed Production by Bean Plants”.  This title gives the potential reader a much better idea of what the experiment was about.

ABSTRACT - Skip a line after the Title and write and underline “Abstract”

This will come in with the final paper. An abstract is a summary of the project in 250 words or less. While the abstract comes first in the report, it is often written last. The abstract must include the following components: TITLE (ALL CAPITAL LETTERS), a statement of the problem (what question is your project trying to answer?), purpose, hypothesis, procedure used, what measurement was done, conclusions. You may also include unsolved aspects of the problem or new problems identified (not required in the abstract). Put the abstract with your written report.

Hypothesis and Introduction – underline all section titles
State the hypothesis for your experiment.  Use these words: “The hypothesis for the experiment was...”.
In the next THREE paragraphs, DISCUSS fully three different pieces of information that justify your hypothesis.  You must provide parenthetical in text documentation of all your information (in parentheses, write a number that corresponds to the correct reference source listed at the end of the paper in the Bibliography). Remember....the introduction section of your experiment project must be 1500 words long...much longer than for a typical lab.

Materials and Methods

Describe exactly how the experiment was conducted.  Write in past tense only.  Past tense, passive voice is preferred, like this" Six hundred grass seeds WERE PLANTED", not "I planted six hundred grass seeds." Do NOT write this section like a list of instructions.  You explain what you did, not how someone else should do the experiment.  This section should be so detailed and so well-written that the reader can do exactly what you did simply from reading your Materials and Methods section.  The results of an experiment are not considered valid unless another scientist can repeat your experiment and get similar results.  Obviously, another scientist must be able to read your M&M section and repeat your experiment.

Data and Results
Give the results using an appropriate format: graph, chart, text, drawings, etc.  Include any descriptive statistics such as the average or standard deviation.  Include the results of any statistical analysis.   Be sure to include ALL pertinent observations, measurements, calculations, etc.  ALL class data must be included in the Results section in chart form.

Discussion and Conclusions
Include all of the following, but do not list in this numerical form

Explicitly state all conclusions you can draw from your results; state whether the experiment supported or did not support your hypothesis (do NOT say that the hypothesis PROVED your hypothesis.  One experiment NEVER proves a hypothesis).  Begin the first paragraph with “It was concluded from the experiment that ...”.

Evaluate the results; explain why you think the experiment turned out the way it did; explain why the manipulated variable had the effect it did on the experiment.  The second paragraph should begin “The experiment turned out the way it did because...”.

DISCUSS problems with your experiment.  How would you do the experiment differently to make it better?  The third paragraph should begin “The experiment had the following problems ...”.  After explaining the problems, you should write “These problems could be fixed by...”

List future experiments you would suggest as follow-ups to the experiment you described.   The fourth paragraph should begin “Logical future experiments would include...”.  Do NOT simply re-state the improved versions of your experiment from section 3 of the Discussion.

The Discussion section MUST be at least 4 paragraphs in length.

Bibliography
- you must include COMPLETE bibliographic references for each source used in the preparation of your paper.

**ADDITIONAL NOTES**
- DO write in the passive voice (no use of personal pronouns)
- DO use past tense throughout the paper
- DO NOT use the word “Prove”.  Use the word “Support” instead.
- DO NOT start a new page for each section
- DO NOT use abbreviations or contractions

- DO NOT plagiarize.

LAB REPORT COMMENT GUIDE
TITLE
A. Title not specific enough
B. No “title” label required for title

INTRODUCTION
C. What is your hypothesis?
D. Hypothesis is not supported by information in Introduction
E. Justification for hypothesis does not relate to the experiment performed
F. Needs 3 pieces of information related to the hypothesis
G. Introductory information needs more discussion
H. Needs parenthetical documentation (where did you get your information?)
I. Use correct documentation format (parentheses, number of correct source, period after parentheses)
J. Re-write information in your own words (don’t plagiarize)
K. Don’t include information you don’t understand

MATERIALS AND METHODS
L. List materials (do NOT write sentences for materials)
M. Write the materials and methods as if YOU personally did the who le experiment without your classmates’ help
N. Describe how and what measurements were obtained

DATA AND RESULTSP. Do not graph individual data; graph the average of all the data

Q. Data table formatted incorrectly

R. Graph formatted incorrectly
S. Your calculations are incorrect
T. Graphs must include title, labeled axes, and consistently numbered axes
U. Incorrect dates

DISCUSSION AND CONCLUSIONS
V. Clearly state your conclusion

W. Explain the outcome
X. Must list 3 problems with experiment, describe why each is a problem, and explain how to improve the experiment next time.  “More replication” is assumed.
Y. Must list three future experiments that are DIFFERENT than the experiment conducted.
 Do NOT include the improvements in the “Future Experiments” section.  Use a separate complete sentence for each future experiment.

BIBLIOGRAPHY
Z. Sources must correspond to references in parenthetic al documentation
AA. You must distinguish between anonymous authors with the same date< BR> BB. Alphabetize by first author’s last name

MISCELLANEOUS

CC. Use correct scientific name format
DD. Use passive voice only
EE. Write in past tense
FF. Use paragraphs that contain single topics
GG. Needs much more detail
HH. Sentence structure problems
JJ. Each section (except “Title” must be labeled)

**Lab Report Example**

First and Last Name

The Effect of Phosphorus Fertilizer on the Production of Green Beans
Block, Course, Teacher

Wheeler High School

First.Last@wheelermagnet.com

The Effect of Phosphorus Fertilizer on the Production of Green Beans

INTRODUCTION

The hypothesis for the experiment was that green bean plants receiving the highest rate of fertilizer application would grow the largest and produce the greatest weight of beans.
All living things utilize the molecule ATP as a source of energy (Miller and Levine, 1995). ATP, adenosine triphosphate, is made up of carbon, hydrogen, oxygen, nitrogen, and phosphorus atoms (Lehninger, 1976).  A cell that does not receive phosphorus would not be able to make ATP and therefore it would not be able to carry out reactions that require a source of energy.  Growth and seed production must require energy.  Green bean plants must therefore need phosphorus to build ATP for the process of making beans.  It follows then that the more phosphorus, at least up to a point, that is available for bean plants, the more beans they can make.

Indeed, this general concept has been demonstrated in previous experiments.  Rodale et al (1966) grew a variety of crops to which they added superphosphate fertilizer at the rate of 50 pounds per acre.  They found that all the crops (carrots, collards, and zucchini squash) grew larger, produced greater yields of crop, and produced more seeds when they received phosphorus fertilizer at the rate of 50 lbs/acre.  They obtained this same result in subsequent years working with different crops as well (Rodale et al, 1988).

The amount of fertilizer added may affect the growth of plants. Lowrance (1985) planted hydrangeas receiving different amounts of potassium phosphate fertilizer.  He grew plants with 0, 5, 10, or 25 pounds of fertilizer per acre. He found that the plants with the least fertilizer grew the least and produced the fewest and smallest flowers.  They failed to produce any seeds at all.  The plants receiving the most fertilizer produced the most flowers and seeds, the largest flowers, and the plants grew the tallest.

MATERIALS AND METHODS

Blue giant variety green bean plants were planted in an open field next to the front entrance to North Cobb High School.  25 rows of seeds were planted.  Seeds were planted 3 cm deep and 15 cm apart within rows.  Each row was 25 meters long.  So there were approximately 165 plants that grew in each row.  The soil was prepared prior to planting by tilling to a depth of 30 cm.  Each row of beans received a different amount of bone meal fertilizer which is an organic phosphorus fertilizer.  5 rows were randomly selected and marked to receive no fertilizer.  5 rows received 5 kg/ha of bone meal, 5 rows received 10 kg/ha, 5 rows received 25 kg/ha, and 5 rows received 50 kg/ha.  All fertilizer was applied as a water solution sprayed at the soil surface above where the seeds were planted.  The field was irrigated once/week with one inch of water unless rain fell during that week.
Sixty days after the seeds were planted, the plants had grown and begun to produce beans.  Ten plants were randomly selected from each row.  Those plants were cut off at ground level and immediately weighed.  Next, the beans were removed from the plant and they too were weighed.

RESULTS

Although no specific records were kept, it was noted that bean plants fertilized with 25 kg/ha of bone meal began to flower and produce beans before the other plants.  Plants receiving 50 kg/ha had leaves that were the darkest green in color.  Please see figures 1 and 2 for a summary of the results.  See Table 1 for a list of weights of all plants and beans.

Table 1: Raw Data, Phosphorous Fertilizer on Bean Plants

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Figure 1: The Effect of Providing an Example Graph on Students' Abilities to Follow Directions

DISCUSSION

It was concluded from the experiment that bean plants receiving 2 5 kg/ha of bone meal grew the largest (based upon weight) and produced the most beans (based upon weight).

The hypothesis suggested that the beans receiving the most fertilizer would produce the most beans and grow the most.  The hypothesis was not supported by the experiment.

Apparently, the beans receiving 25 k g/ha of bone meal were receiving enough phosphorus to make plenty of ATP for their purposes.  Higher rates of fertilization may have interfered with water uptake by the bean plants and therefore inhibited their growth.

 In previous experiments in class (Klum, 2000), it has been shown that “cells” immersed in concentrated salt solutions lose water.  The bean plants receiving 0, 5, or 10 kg/ha of bonemeal obviously were not getting enough phosphorus because they didn’t do as well as the beans receiving 25 kg/ha of bonemeal.

Of course, these results support Odum’s (1973) subsidy-stress concept which states that for all growth factors, there is an optimum amount that stimulates growth most.  More or less of that factor will result in less growth. There were some problems with this experiment.  When the fertilizer was applied, the wind was gusting and some fertilizer could have blown onto adjacent rows that were receiving a different amount of fertilizer.  The fertilizer should be applied on a calmer day.   When the beans were harvested, the beans were harvested in order by treatment.   All the 0 kg/ha beans were harvested first, then the 5 kg/ha beans were harvested, etc.  When all the beans were done being harvested, they were weighed.   So some of the beans sat out longer before being weighed and therefore dehydrated more and weighed less.  Obviously, all the plants and beans should have been weighed as they were harvested.  Finally, the plan to harvest only beans found on the 60th day from planting was a bad one.  The plants receiving 25 kg/ha of bonemeal were the most mature at that time.   It could be that the other plants would have produced more over a longer period of time.  All the beans produced by the plants should have been collected throughout the entire growing season rather than just the be ans produced by the 60th day.

Based on the results from this experiment, the following experiments are proposed:

1) Conduct an experiment to see more precisely what amount of fertilizer gives the best yield of beans.  Add bonemeal amounts that vary from 10-50 kg/ha.  It is now known that the best yield is somewhere between those amounts, but it may not be exactly 25 kg/h a as we found in this experiment.

2) See if water affects how well the bonemeal works.  Add 25 kg/ha of bonemeal to all the bean plants but vary the amount of water added. 3) See how bean production is affected by the type of fertilizer added.  Compare the growth of beans using phosphorus, nitrogen, and potassium fertilizers.

REFERENCES

Klum, H. 2000. Unpublished data.

Lehringer, G.  1976.  Molecules of life: Adventure s in organic chemistry.  Prentice-Hall, New York.  pp 25-26.

Lowrance, R. 1985.  The effect of phosphorus on hydrangea growth, flowering, and seed production.  Journal of Horticultural Science. 15:231-245.

Miller, R. and T. Levine.   1995.  Biology.  H oughton Mifflin, Philadelphia.  pp 31-32.

Odum, E.P. 1973.  <http://www.ecology.uga.edu/subsidy-stress.html>

Rodale, R., L. Boring, T. Swift. 1966. “Phosphorus”.  Encyclopedia of Organic Farming. Rodale Press, Poughkeepsie, NY.

Rodale, R., L. Boring, D. Boring. 1985. Phosphorus kicks veggie butts.  Organic Farming. 36: 112-114.

**What Should Be Turned In With My Final Project?**

A) Logbook

Your logbook with up-to-date entries will be presented on a display table along with your project display. The logbook is a diary of all the work you have done on each part of your project, including the library research notes, graphs, abstract, experiment, data measurement results, and corrections to the written report suggested by your teacher. Composition notebook is recommended.

B) Written Report

The report is written in the same style as a laboratory report, with all sections from the semester. You should retype the report you turned in with all corrections I have suggested.

C) Visual Display

Your display must stand up all by itself on a table top. You can build it yourself or use a pre-made cardboard (trifold) display. The display must have certain headings that are neat and easy to read, such as TITLE, PURPOSE, HYPOTHESIS, PROCEDURE, RESULTS (GRAPHS) and CONCLUSIONS. You must explain your compelling reasons for doing this research. On the display board, explain sufficient background information so the audience will understand your project without needing to read your research report.

Photographs of your project MUST be mounted on the display. You may include some of your project equipment sitting in front of the display on the tabletop. (Some equipment and materials are prohibited; see the state list). Never display living or dead animals or plants, food, poisons or sharp instruments. The display must meet these maximum size requirement s: 76 cm (30 in) deep 122 cm (48 in) wide 274 cm (108 in) tall

The logbook and written report must be displayed on the table in front of your display. The approval form signed by your parents and me, plus any permission forms needed must also be displayed on the table.

D) Art Data

You will interpret the data you collected into an artistic form. Within visual arts, you may use any medium – sculpture, paint, digital design, anything! You must incorporate at least one element of art and one principle of design, and you must be able to explain your artistic choices.

E) Oral Presentation (Minimum: 7 minutes; Maximum: 10 minutes)

Each student will set up their project display in front of class and explain their purpose, procedure, results and conclusions. Students will also answer questions about their research.

**Final Project Rubric**

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| **Possible Points** | **Criteria** | **Score** |
| **Experiment Design (20 points total)**  |
| 5 | **Creativity.** The experiment was relatively creative, using new methods, unique materials/equipment. It reached new or creative conclusions. |  |
| 5 | **Purpose.** The experiment has a clearly stated objective or hypothesis. The experiment carried out the purpose effectively. |  |
| 5 | **Data.** The experiment controlled variables effectively to ensure validity of data. Accurate and detailed measurements were obtained, sufficient data was collected. |  |
| 5 | **Significance**. What is the purpose of this experiment? How is it relevant and/or how will the data help science or society? |  |
| **Final Paper (15 points)** |
| 10 | **Clarity.** The paper has taken all reviewers’ comments into account and has improved upon each original draft. The paper flows like one unified story as opposed to choppy, disparate sections. |  |
| 5 | **Format.** The paper is presented in proper APA format. All sources are cited both parenthetically and in the references section. |  |
| **Oral Presentation (20 points total)** |
| 5 | **Comprehensiveness.** Presented adequate background, a clearly stated hypothesis, procedure, results, and analysis of the results. |  |
| 5 | **Engaging.** The presentation is overall very professional and engaging. The student speaks clearly using eye-contact with audience, pacing, and volume. |  |
| 5 | **Professional.** Presented material in a serious and professional manner. Gave respect to other student researchers |  |
| 5 | **Questions.** Adequately answered questions and gave respect to others |  |
| **Display (20 points total)** |
| 5 | **All Info**. All information (background to discussion) displayed on board. It is not too wordy but conveys a brief message of each.  |  |
| 5 | **Attractiveness.** The exhibit is visually appealing and clear. It is self-explanatory because it is clearly labeled. Graphs and data are displayed appropriately. |  |
| 5 | **Photos.** A photographic record of the process and results is displayed. The photos enhance the presentation. |  |
| 5 | **Logbook.** Logbook is present and adds to the display by providing unique information (raw data, background information). The logbook has a clear table of contents and/or sticky notes to indicate important pages. |  |
| **Art Data (25 points total)** |
| 5 | **Attention-Grabbing (ooh).** The piece engages the audience in an impactful way. It is visually engaging and personally or socially relevant. |  |
| 5 | **Makes Sense (aah).** Through the piece, data is clearly communicated and easily understood. The key and/or written explanation allow for understanding of the project. |  |
| 5 | **Artistic elements.** The student incorporates at least one element of art and one principle of design.  |  |
| 5 | **Craftsmanship.** An investment of time and attention to a quality product is evident in its design. The piece is neat and well-constructed. |  |
| 5 | **Creativity.** Is this an original solution to the design challenge? Does the student make connections or combine ideas in a unique way? |  |
| **TOTAL POINTS** |