

## REQUIREMENTS/CRITERIA: DA&I

**REMEMBER:** Proper MLA format for ALL figures and tables. No paragraph should begin with a figure. Use proper grammar, structure, and spelling/punctuation.

### 8. Data Analysis and Interpretation

Use this section to calculate and report any statistical analysis you have performed with your data.

- Percent error for each experiment should be reported in a table in this section. Briefly discuss how calculating the percent error while the experimental trials were ongoing was used as a guide to check proper execution of experimental procedures and adjustments that were made as a result.

#### How to calculate percent error

Experimental value is what you calculated in the lab.

**Published** (true) value is the published value for that property.

You need to calculate % error for each property and this should be reported in a table.

$$\%error = \frac{\text{Experimental Value} - \text{True Value}}{\text{True Value}} \times 100$$

For each experiment:

- Create an appropriate graph of the data. Also create a normal probability plot to check for normality of data if less than 30 data points. Choose a statistical test that is appropriate for your data. Discuss why this test is the correct one to use and show that the necessary conditions have been met.
- State the null and alternative hypotheses. Use mathematical notation and identifying subscripts. Then tell the reader what this means.
- Include the equation for your test statistic. Explain the variables of the equation(s) in words in terms of your data.
- Show the probability graph from the software and explain the p-value in relation to your problem.
- Explain the results of your statistical test. (Reject or fail to reject the null hypothesis and explain the meaning of the p-value. State what that means in relation to the problem - in other words state results of test in non-statistical terms.)

\*In an appendix, include one sample calculation for each result calculated (see number 12). This includes: percent error, thermal expansion, specific heat and the statistical test. Properly format and discuss your work (see Appendix A for details).

The following will be turned in to your math teacher:

- **Properly formatted Data & Observations**
- **Data Analysis & Interpretation**
- **Appendix A (Letter depends on your paper) Formulas & Sample Calculations**

## REQUIREMENTS/CRITERIA: DA&I

**Experimental Recap** -- Since I have not been involved with your research much thus far, you will need to give me a brief description of your project. You should tell me the purpose of your project and what experiment you are conducting. Also include briefly what data you are measuring and units used. Do this on a separate sheet of paper – this is for ME ONLY and will NOT be turned in as part of your final paper.

**Data & Observations** - I will not be 'grading' this portion of your submission, but you will lose points if it is NOT turned in. Make sure you give me the copy that is formatted properly\* – I want to see the version turned in to Mr. May and Mrs. Hilliard. I can't check the accuracy of your analysis if I don't have the numbers you used to do the analysis.

**Data Analysis & Interpretation** - this is where the majority of your math grade will be earned.

First, you will need to discuss the reliability and validity of your data. (Think: CRR). This would be a good place to present the percent tables and any discussion of correction factors (if appropriate to your experiment).

The next couple paragraphs will present **DESCRIPTIVE STATISTICS** and the related graphs. Decide which data plot(s) are appropriate (histogram, **box plots\***, line graphs, **normal probability plots**, etc.) and make sure to label axes!! Comment on any trends or patterns present. Results of one variable statistics will be helpful in this discussion as well. If you have less than 30 trials, discuss the normality of your data. Use your plots and any other relevant information to determine this normality. Also, any discussion of physical characteristics that might impact the interpretation of your results can be mentioned here. Remember to interpret the results but save the science behind the conclusions for the Conclusion section of the paper

Next you will discuss your statistical test. You must begin this portion by stating what analysis was performed, **why** this test is appropriate to your situation, and how you know the results are valid. Also show that the conditions of the test have been met. After this, state the null and alternative hypotheses using both mathematical symbols AND stating in words what those symbols mean in the context of your experiment. Don't assume that the reader will know what the subscript means. [Be sure to format your null and alternative hypotheses as a figure.]

After all of this, then you will show and discuss the results of your statistical test. **If** you are running a t-test, remember to identify your t-value. Show a screenshot of the t-test calculator screen and the p-graph as a figure and explain the p-value in relation to your problem. Remember your three sentence summary!

\*See the data table and box plot formatting document on Mrs. Hilliard's and my websites.

## Appendix A Formulas & Sample Calculations

### How to reference and format sample calculations

**Note:** The original formula is centered, but not the actual sample calculation and that the units are identified throughout the work. Sample Calculations are formatted using Equation Editor.

#### Example:

To analyze our data we needed to use the following equation where energy,  $E$ , of a single quantum number equals a constant  $h$ , times its frequency,  $\nu$ .

$$E = h \times \nu$$

Shown in figure 1 below is a sample calculation using the equation for the energy of a photon.

$$\begin{aligned} E &= h \times \nu \\ &= (6.623 \times 10^{-34} \text{ J-s})(5.09 \times 10^{14} \text{ s}^{-1}) \\ &= 3.37 \times 10^{-19} \text{ J} \end{aligned}$$

Figure 1. Energy Equation

Sample calculation of the energy of a photon.

This section will include properly formatted sample calculations for all appropriate calculations such as **percent error**, specific heat, linear thermal expansion, correction factor for calorimeter, and your **statistical test**. For example, if you are performing a  $t$ -test you would show the formula for it and also define each variable in the anchor/introduction. Then you would show the substituted numerical values and the result. Don't forget to include units of each value in your calculation. Each different formula/sample calculation should begin with an introductory sentence. No paragraph should begin with a figure. Pay CLOSE ATTENTION to the example in your research manual, also copied above.

**Points earned are given based on the degree to which the assignment meets the established criteria, and the quality of that portion of the work. Simply having required items present does not guarantee full points.**

**Math Teacher Rubric for Sophomore Research  
Data and Observations and Data Analysis & Interpretation**

We want your best work that shows time, effort, care, and energy has been spent perfecting this part of your paper.

\_\_\_ (5 pts) **Experimental Recap**  
1 to 2 paragraphs ON A SEPARATE PAGE, summarizing your experiment, the variables, hypothesis, etc. (Remind the math teacher about what you are doing. This is NOT part of your final paper in any way.)

\_\_\_ (5 pts) **Data and Observations**  
FOLLOW MANUAL - Should be easy to understand and follow.

**Data Analysis & Interpretation\*\*** In the Data Analysis & Interpretation section you are to clearly state “what” the numbers mean. ALL OF THEM! The conclusion will detail “Why” scientifically your results could/would/should have happened.

\_\_\_ (20 pts) **Descriptive and Another Statistical Treatment** FOLLOW THE MANUAL  
And details presented in the Requirements/Criteria document.

**Descriptive**

In particular...

- Discuss reliability and validity of your data. (Think: CRR & Percent error)
- Good plots with labels and scales marked.
- Consistent uniform scales throughout (unless compelling reason).
- Special attention paid to discussion of trends and patterns.

**Another Statistical Treatment**

In particular...

- Show that the test being used is appropriate.
- Discuss conditions necessary to be met.
- Identify null and alternative hypotheses in the context of your experiment (i.e. words in sentences) and mathematical notation (identify your variables/ subscripts).
- Screenshot of results and p-graph.

\_\_\_ (10 pts) **Interpretation**  
Summary of results of analysis. (Now that you have run all these tests and p-values and hypotheses.....what's the bottom line for the reader?)

\_\_\_ (10 pts) **Appendix: Formulas & Sample Calculation(s)** FOLLOW MANUAL  
In particular...proper format and values labeled with units.

\_\_\_ (5 pts) **Proper MLA Format**

\*\* Incorrect math or incorrect interpretation of results will result in a grade NO HIGHER than a C.