

Everyone in the research team is responsible for turning in their own individual Lab Report with their own unique and individually written Analysis and Conclusion/Summary. THE ONLY PARTS OF YOUR PAPER THAT CAN BE IDENTICAL are the: **7.1a** Research Question, **7.1c** Variables, **7.1d** Hypothesis, **7.2**.Procedure, **7.3a**. Raw Data Table(s). The Grading rubric is provided on the next page.

People in my group: #1 _____ #2 _____ #3 _____

You have the following materials available to you:

- A balance
- Thermometers
- Beakers
- Graduated cylinders
- Baking soda, NaHCO_3 (s)
- Calcium chloride, CaCl_2 (s)
- Citric Acid, $\text{C}_6\text{H}_8\text{O}_7$ (s)
- Distilled Water, H_2O (l)
- Sodium hydroxide, NaOH (s)
- Vinegar, CH_3COOH (aq)

Potential Research Questions :

Choose from one of the questions 1-3, or your team can pose your own testable research question.

1. Does the amount of reactant(s) vary the amount of energy absorbed/released?
2. Can we predict how much energy will be absorbed or released when reactant amounts are varied based on evidence collected in lab?
3. Are some reactions more endothermic/exothermic than others? How can we tell?

Notes:

AST7.1: Forming a Question or Hypothesis	
1	<ul style="list-style-type: none"> Question or hypothesis cannot be investigated using available resources. Question or hypothesis is missing, or does not seem to relate to the lab. Purpose of the lab is not identified. Shows little to no background knowledge.
2	<ul style="list-style-type: none"> Question of hypothesis that can only be partially answered with the investigation. The question or hypothesis is not specific enough/ only part of the purpose of the lab is identified. Provided relevant, but insufficient background information.
3	<ul style="list-style-type: none"> Question or hypothesis can be investigated through the lab (includes dependent and independent variables) Question of hypothesis is specific enough to encompass the goals of the lab. Provides sufficient background science knowledge.
4	<ul style="list-style-type: none"> Question or hypothesis points towards a broader understanding of scientific relationships (interaction, dependency, correlation, causation). Question or hypothesis clearly guides the investigation by including dependent and independent variables. Provides well documented background science knowledge to establish context for the investigation

AST7.2: Designing/Completing an Investigation	
1	<ul style="list-style-type: none"> Procedure is not clearly followed, and/or steps are missing or incomplete. Key safety issues are not addressed. Presents a design that will provide data of neither sufficient quality nor quantity to address the question or hypothesis.
2	<ul style="list-style-type: none"> Major procedural steps are followed, but may have minor inconsistencies. Major safety issues are addressed, but students may need a reminder. Presents a design that will provide data of insufficient quality and/or quantity to fully address the question or hypothesis.
3	<ul style="list-style-type: none"> Procedure is accurately followed using appropriate equipment. Appropriate safety issues are considered. Presents a design that will provide data of sufficient quality and quantity.
4	<ul style="list-style-type: none"> Procedure is accurately followed using appropriate equipment and scientific methods. Appropriate safety issues are considered for all aspects of the investigation. Presents a design that will provide high quality data that can be used to address the questions or hypothesis.

AST7.3: Collecting and Presenting Data	
1	<ul style="list-style-type: none"> Records data that is inconsistent with the procedure/purpose of the lab. Data is missing units and/or labels Displays inaccurate incomplete or disorganized data.
2	<ul style="list-style-type: none"> Collects data that are consistent with planned investigation. Data has some incorrect or missing units or labels. Displays data in a manner that communicates results understandably, but may be somewhat incomplete or disorganized.
3	<ul style="list-style-type: none"> Collects data that is consistent with the planned investigation. Records reasonable raw data using appropriate units and labels. Significant figures are reasonable, but may have a few errors. Displays appropriate data in an organized format
4	<ul style="list-style-type: none"> Collects complete and detailed data that is consistent with the investigation. Records accurate raw data using appropriate units and significant figures. Displays appropriate data in a manner that is easy to read, and highlights relationships to be analyzed.

AST7.4: Analyzing and Interpreting Results	
1	<ul style="list-style-type: none"> Conclusions are not clearly related to the question or hypothesis. Conclusions are not supported by evidence, or have inaccurate explanations. Provided little to no evidence that the procedure and data have been reviewed to identify uncertainties or errors.
2	<ul style="list-style-type: none"> Conclusion addresses the question or hypothesis, but is only partially supported by evidence. Conclusion is overly simplified, or incomplete Provides minimal evidence that the procedure and data have been reviewed to identify uncertainties or errors.
3	<ul style="list-style-type: none"> Conclusions are valid, address the question or hypothesis and are supported using the data. Identifies possible patterns within the data. Provides evidence that the procedure and data have been reviewed to identify sources of uncertainties or errors, and discusses how these might affect the results.
4	<ul style="list-style-type: none"> Conclusions are valid, comprehensive, address the question or hypothesis, and are clearly supported by data. Explains possible patterns within the data. Provides evidence that the procedure and data have been reviewed, providing significant sources of uncertainties or errors, and discusses how these might affect the results suggesting insightful improvements.

AST7.1 Formulate the Question: Based on observations and science principles, I can formulate a question or hypothesis that can be investigated through the collection and analysis of relevant information.

7.1a. Our Research Question:

7.1b. Define the Problem

Background

Write 2-3 sentences or more to describe the science concepts related to your investigation. This is the stuff you draw from in providing the “because...” part of your hypothesis. It could be as simple as, “On page ___ of the text book,” or “The lab handout states...” You must include Works Cited section at the end.

7.1c. Variables

IDV = independent variable; DV = dependent variable; CV = controlled variable.
Include a detailed explanation of how you will control the CV’s. If temperature is a CV, how will this be controlled? Make sure there is a step in your procedure for this. You can summarize the variables in the table and follow up in a short paragraph or bullet points. Include diagrams, schematics of equipment set-ups or whatever else can help the reader know exactly how to repeat your experiment to get similar results.

Independent Variable (x-axis)		Describe the levels or the range of data:
Dependent Variable (y-axis)		How this will be measured:
Controlled Variables		What each should be and how it will be kept the same.

7.1d. Hypothesis (A tentative and testable statement that relates the independent variable and dependent variable, and that includes correct scientific support from your background.)

AST 7.2 Design the Investigation: I can design and conduct a controlled experiment, field study, or other investigation to make systematic observations about the natural world, including the collection of sufficient and appropriate data.

7.2. Procedure

The procedure section includes a list of safety precautions and statements, a detailed materials list of the type, size, kind, and quantity of all materials for the lab and the step-by-step procedure.

7.2a. Safety

7.2b. Materials List (List which materials and chemicals you will use. How many/much? What size? Etc.)

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7.2c. Procedure (Numbered list of steps you did to carry out your experiment.)

AST 7.3 Collect and Present Data: I can collect, organize, and display sufficient and appropriate data to facilitate scientific analysis and interpretation.

7.3 Data Tables, Patterns, and Graphs

Data tables need to have a title, units in the column headings and no units in the main body of the table. Every graph must have a title, axis labels that include units and the axis scale needs to reflect the level of precision in your experimental measurements.

7.3a. Raw Data Table(s)

(Where you recorded data during the experiment BEFORE transformation)

7.3b. Calculations

Include every formula you will use no matter how simple. Remember to use a reasonable number of digits for calculations. Use your data to show one example calculation for each formula. Remember units.

7.3c. Processed Data Table (May attach to the back of this report and refer to it here.)

This needs a title, units and correct sig figs. This table contains whatever is in your graph(s).

7.3d. Graph or Model to Display Data (May attach to the back of this report and refer to it here)

Follow the rules for graphing. Watch your sig figs and decimals in calculations. Make sure your precision is reflected in axis labels. It needs a descriptive title.

AST 7.4 Analyze and Interpret: I can summarize and analyze data to draw a valid and supported conclusion to communicate the findings of an investigation and identify uncertainties.

7.4a. Patterns

Describe and analyze patterns in your data table or graph. Is the relationship linear, exponential, etc.? What is the relationship between your IV and DV? Have you selected the appropriate graph for your data? Is a line of best fit used?

7.4b. Conclusion (Evaluating the Hypothesis)

Does your data support your hypothesis or not? Is there outside research you could reference that supports your idea and strengthens your argument? Use your data (aka numbers!) to back up your claim.

Here is a sample outline:

1. Introduce your research question to the reader.
2. Restate your hypothesis.
3. Evaluate your hypothesis. Did your results support your hypotheses for each reaction? Discuss the data from the lab. Refer to the data table or graph. **USE NUMBERS TO SUPPORT YOUR CLAIM.**
4. Your method probably wasn't perfect, that's ok, as long as you discuss the issues. Discuss the tools used and how you used them. Did you calibrate your thermometer? Did you use the same one for every experiment? Did you adequately keep your controlled variables the same? How many trials?
5. Everything can be improved so don't skip this part. This section needs to be: Specific, realistic, and based on literature research after your experiment
6. Propose a follow-up research question based on your results from this experiment. What do you want to research next about thermochemistry? [YOU CANNOT SAY, "nothing. "]
