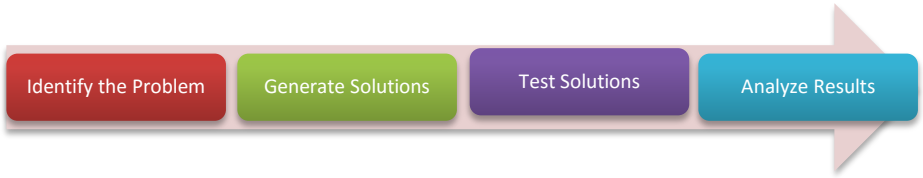
DUE 5/25/16 (Seniors—this is your Final Exam!)

Chemistry 1 Your Name:_____ Period ____

YOU WILL WORK IN GROUPS OF THREE (3). NO EXCEPTIONS!
People in my group: #1_____ #2 _____

Engineering a Device to Measure Heat Transfer



AST 8.1 Identify and Define the Problem I can describe a problem to be solved through the process of engineering, describe the relevant principles that relate to the problem, and identify appropriate criteria and constraints for a solution.

Highly Proficient-HP (4)	Proficient (3)	Nearly Proficient (2)	Developing (1)
• Scientific principles are fully explained and linked to investigation. • Problem is detailed. • Suggests why criteria and constraints limit possible solutions.	• Scientific principles are related to investigation & explained clearly. • Problem is completely described. • Identifies major criteria and constraints.	• Scientific principles are somewhat related to investigation and explained simply. • Problem partially described. • Identifies some criteria and constraints.	• Scientific principles are not presented or are not related to investigation. • Problem not described or unclearly described. • Criteria and constraints are incorrect or omitted.

AST 8.2 Generate Possible Solutions - I can evaluate and select an engineering solution from a range of possible options and defend that solution for testing using trade-offs, criteria, and constraints.

Highly Proficient-HP (4)	Proficient (3)	Nearly Proficient (2)	Developing (1)
Everything in Proficient Column Plus: • Describes three possible solutions, • Uses initial testing data, or supplemental research to support test choice.	• Describes two possible solutions. • Evaluates pros and cons of each solution (2 of each). • Chooses 1 solution to test. • Explains why criteria and constraints support choice to test.	• Describes one possible solution. • Partially evaluates pros and cons of the solution (2 each). • Chooses 1 solution to test. • Chooses the solution to test partially based on criteria and constraints.	• No evidence multiple solutions were considered. • Does not evaluate pros and cons of the solution. • Does not choose a solution based on criteria and constraints.

AST 8.3 Test Solution(s) and Collect Data - I can test solution(s) by collecting, organizing, and displaying data to facilitate the analysis and interpretation of results.

Highly Proficient-HP (4)	Proficient (3)	Nearly Proficient (2)	Developing (1)
Everything in Proficient, Plus: • Evaluates and explains the data. • Explains how the data was used to determine modifications. • Proposes reasonable modifications to Prototype #2 that are supported by test data.	• Creates a prototype that can be tested based on criteria and constraints. • Collects data that will lead to prototype evaluation. • Displays data in tables and graphs for analysis. _____ • Modifies and retests 2nd iteration prototype • Displays data showing how modifications changed the prototype.	• Creates a prototype that can be tested partially based on criteria and constraints. • Collects insufficient data to lead to prototype evaluation. • Display data in tables and graphs for analysis but choice of display is incomplete or unusable. • Proposes a modification to prototype but does not retest it.	• Creates a prototype that can be tested that is not based on criteria and constraints. • Collects data unrelated to prototype evaluation. • Data is not displayed or is missing completely. • Unable to propose or test modification based on test results of original prototype.

AST 8.4 Analyze and Interpret Results - I can summarize and analyze data, evaluate the proposed solution, identify uncertainties, and suggest design improvements.

Highly Proficient-HP (4)	Proficient (3)	Nearly Proficient (2)	Developing (1)
Everything in Proficient, Plus: • Recommendation includes a prediction of how modifications will affect 2nd iteration prototype (IF it was not possible to modify and test 2nd iteration) • Solutions to limitations are explained in detail. • Cost and profit analysis presented.	• Recommendation is related back to criteria and constraints and data collected. • Uses multiple types of data to explain strengths and weaknesses of the final prototype. • Describes several future modifications with limitations. • Cost to produce discussed in detail.	• Makes recommendation based on the success of the prototype in testing. • Uses some test data to explain strengths and weaknesses of final prototype. • Describes one potential modification that may or may not include limitations. • Costs of prototype are discussed simply.	• Makes no recommendation or it is disconnected to test results. • Little or no attempt to present strengths and weaknesses of final product. • Describes no potential modification or it is unclearly supported by test data. • Costs not discussed

AST 8.1 Identify and Define the Problem I can describe a problem to be solved through the process of engineering, describe the relevant principles that relate to the problem, and identify appropriate criteria and constraints for a solution.

DAY 1 of 4—Prototyping a Heat Container

Brainstorming

If you were tasked with the challenge of designing something with a specific purpose or to solve a problem, (1) what is involved in the design process? (2) How do you know whether or not your design is "good?" (3) What if there are restrictions on your design? How would that affect your design process?

Write your response to the questions above in the space below:

Your task today is to begin the process of designing a heat container. The only information you have so far is that your container must be able to hold something that is as hot as boiling water and retain the heat within the container as best as possible. Your focus is to identify 1) potential materials that you think would be appropriate, 2) Possible designs (shape) of the container; 3) Potential ways you could test the success of your container. List all resources you refer to: textbook, Internet, classmates, etc.

(1) Potential Materials:

(2) Sketches of <u>multiple</u> design ideas:

(3) List some ways to test the success of the design:

References Used

Science Knowledge Needed for Successful Completion of the Project[1]

First and Second Laws of thermodynamics READ pp 482-485

1) The three main ways heat is transferred are: _____, _____, and _____.

2) Conduction is when _____.

3) The study of heat transfer is called _____.

4) Define the first law of thermodynamics in your own words. _____

_____

5) Provide evidence (an example!) to support the first law of thermodynamics._____

_____.

6) Define the second law of thermodynamics in your own words. _____

_____.

7) Provide evidence (an example!) to support the second law of thermodynamics._____

_____.

Measuring Heat Transfer READ pp 488-491

8) Thermal energy describes _____.

9) What is the difference between thermal energy and temperature? _____

_____.

10) If you heat up a large and a small sample of cold water to the same temperatures, explain why it takes more energy to heat up the larger sample?_____

_____.

STOP HERE for today.

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[1] Required for HP (4).

DAY 2 of 4—Design a Container to Meet Criteria & Constraints

Request for Proposal

Dear Chemistry Students:

We need your help! We are looking for the best design in creating a device that allows heat transfer inside and can hold liquids, but does not transfer heat to the surroundings outside of the container. We need to mass produce these devices at a minimal cost and intend to bundle them with our most popular lab kit, Specific Heat of an Unknown Metal. I am sending two types of cups from our warehouse to use in your design—White Paper Cups and Styrofoam Cups. The cost of the White Paper Cup is $0.04 per cup and for the Styrofoam, the cost is $0.03 per cup.

Please limit your design to include no more than 3 cups, in any combination you like. Remember—we want the heat loss to the outside of the container to be as close to zero as possible. Also, the user has to be able to measure the temperature of the substances inside the container without have to take it apart to do so.

Please submit your prototype and supporting data explaining why we should choose to manufacture your design. I am looking forward to your creative solutions to this engineering design challenge.

Sincerely,

Cal

Cal R. Imeter

President and CEO, CHEEP Lab Supplies

Identify Criteria and Constraints

Criteria: What is the functional purpose of your product (what is the goal)?

Constraints:

Based on Mr. Cal R. Imeter's request, what are your restrictions (constraints)? List the main restrictions. What is a Specific Heat of an Unknown Metal lab? How might it restrict the design?

1.

2.

3.

Materials Testing—Which Cup Retains Heat Better?

You have Styrofoam and Paper Hot Cups sent by the CHEEP Lab Supplies people. How will you decide which cups to use in your prototype? Write a procedure to test the heat retention of the cups.

Materials Available for Testing:

- Tap water
- 250 mL Beakers
- Hot plate or Microwave Oven
- Tongs to transfer Hot Containers
- 1 Paper Hot Cup (you may not modify)
- 1 Styrofoam Cup (you may not modify)
- Thermometer

Design a Procedure to test heat retention of the cups: (#'d List of Steps You Will Follow)

1.

Teacher Stamp

Raw Data Table (Use the following grid to set up a data table where you will record test data.)

	Temperature (°C)	
Time (minutes)	Styrofoam Cup	Paper Hot Cup
0		

Analysis of Results: Which Cup style retains the heat the best? Must be supported with your test data? Briefly discuss any limitations to your data. Are your results based on a fair test?

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AST 8.2 Generate Possible Solutions - I can evaluate and select an engineering solution from a range of possible options and defend that solution for testing using trade-offs, criteria, and constraints.

[2]DAY 3 of 4—Build, Test, and Redesign Calorimeter Prototypes

Objective: To design, build and test the performance of the first prototype calorimeter.

Sketches of Three[1] Design Ideas for Prototype #1:

Develop and draw three possible prototypes to consider. Be prepared to share and discuss these with your group.

1. Each drawing is to be clearly labeled to show materials, dimensions, modifications to cups, etc.
2. Beneath each drawing, list the pros and cons of that design that pertain to criteria, constraints and the materials test data.

[2] May begin this section on Day 2 if there is sufficient class time. LABEL Calorimeter and shelve it.

Final Design Sketch for Prototype #1

Your group will choose one design from the options considered and shared. Devise a name for your prototype:

Prototype #1 Name: _____

1. What cups have you decided to use? Explain why you are choosing that particular combination or material. (Support your choice with data from the materials test!)

2. Sketch of modified prototype (What you will actually assemble and test!). Label it clearly so that someone else could build this prototype exactly the way your team did.

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AST 8.3 Test Solution(s) and Collect Data - I can test solution(s) by collecting, organizing, and displaying data to facilitate the analysis and interpretation of results.

Design a Procedure to Quantitatively Test the Success of Prototype #1:

1.

Data Collected in Testing the Success of Prototype #1

You will need to continuously monitor the temperature of the water inside your device. You will need to decide how often to record temperature (the interval) and for how long (total time).

Time (Min)	**0**						
Temp (°C)							

Use a T-chart to describe Pros and Cons of Prototype #1(Relative to Criteria and Constraints):

Proposed modifications to Prototype #1 supported by test data and criteria/constraints:

KEEP PROTOTYPE #1!!! Do Not Destroy it. Get my stamp before moving on.

Teacher Stamp

YOU MUST HAVE ALL PRIOR PAGES COMPLETED AND APPROVED BEFORE STARTING.

[1]Redesign, Build and Test Prototype #2

Objective: To design a modified prototype #2 that is supported by test data for Prototype #1 in order to improve performance on the criteria and constraints.

Sketches of Ideas for the Re-designed Prototype #2:

Develop and draw two possible designs to consider that incorporate the modifications you proposed in the previous section.

1. Each drawing is to be clearly labeled to show materials, dimensions, modifications to cups, etc.
2. Beneath each drawing, list the pros and cons of that design that pertain to criteria, constraints and the materials test data.

Prototype #2 (What you will actually assemble and test!)
Your group will choose one modified design from the options considered and shared. Devise a name for your prototype:

Prototype #2 Name: _____

1. What cups have you decided to use? Explain why you are choosing that particular combination or material. (Support your choice with data from the materials test!)

2. Sketch of modified prototype (What you will actually assemble and test!). Label it clearly so that someone else could build this prototype exactly the way your team did.

Final Design Sketch for Prototype #2 (What you will actually assemble and test!)

Teacher Stamp

Write a Procedure to Quantitatively Test the Success of Re-designed Prototype #2:

1.

Data Collected in Testing the Success of Re-designed Prototype #2

You will need to continuously monitor the temperature of the water inside your device. You will need to decide how often to record temperature (the interval) and for how long (total time).

Time (Min)	**0**						
Temp (°C)							

Use a T-chart to describe Pros and Cons of Prototype #1(Relative to Criteria and Constraints):

Proposed modifications to Prototype #1 supported by test data and criteria/constraints[1]:

KEEP PROTOTYPE #2! Do Not Destroy it.

Teacher Stamp

AST 8.4 Analyze and Interpret Results - I can summarize and analyze data, evaluate the proposed solution, identify uncertainties, and suggest design improvements.

DAY 4 of 4—Final Calorimeter Build and Testing

Test Results Summary:

Objective: To propose the best calorimeter to collect data that identifies the specific heat of an unknown metal according to test outcomes for the prototypes considered. [Note: for HP (4) you will write on a separate paper a complete proposal meeting the rubric guidelines and containing answers to the items below.]

Based on the two prototypes tested (temperature vs. time test), our group proposes the calorimeter design described below for your consideration.

Prototype / Expenses / Potential Profit:

Prototype Proposed: _____

Total Cost		**$_____/ calorimeter**

The _____ calorimeter is the best option for Cheep Lab Supplies to bundle with their lab kit: Specific Heat of an Unknown Metal.

The strengths of this calorimeter include _____.

The data (initial or final test results) support these strengths because _____

_____

The weaknesses of this calorimeter are _____.

The data (initial or final test results) indicate the weaknesses of this design because _____

_____.

Future modifications that might be made to the original design would be _____

_____

because _____

_____.

These modifications would make the product more successful because _____

_____.

For HP (4) on AST 8.4 you must write your own proposal on separate paper that meets rubric requirements.