**Engage: Complete the Heat of Combustion Lab in class.**

What is your experimental heat of fusion for paraffin in kJ/mol? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

The theoretical heat of combustion for paraffin C25H52 is 42.0 kJ/g = 1.48 x 104kJ/mol

What was your percent error? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is your experimental heat of fusion for ethanol in kJ/mol? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

The theoretical heat of combustion for ethanol C2H6O is 29.5 kJ/g = 1.36 x 103 kJ/mol?

What was your percent error? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

What were your major sources of error? How could the procedure be modified to improve your results and avoid the error?

**Explore: Individually you will create a more efficient system for measuring the heat of combustion of either paraffin or ethanol in a procedure similar to the one in your Heat of Combustion Lab.**

**Get inspired with some engineering design projects at:** [**http://pbskids.org/designsquad/**](http://pbskids.org/designsquad/)

**Goal**

Build a calorimeter that will measure the heat of combustion for either paraffin or ethanol and improve your percent error by at least 10%.

***1. Identify the problem*** faced with the system used in our Heat of Combustion lab. Your problem should address the shortcomings of the system as well as the procedure we used in the original in class experiment. (Identify at least three)

example:

When performing the lab using our calorimeter in class ……………….problems were discovered with the calorimeter and or the procedure. These problems must be rectified because (or by) ………….)

***2. Brainstorm***

**Research** different types calorimeters used in the laboratory and industry.

Description of calorimeter 1 researched \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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What is it used for?

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***Brainstorm*** things you liked about the calorimeter that you may want to incorporate into your design.

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***Brainstorm*** shortcomings of the calorimeter that you will try to avoid in your design.

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Description of calorimeter 2 researched \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Source \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is it used for?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Brainstorm*** things you liked about the calorimeter that you may want to incorporate into your design.

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***Brainstorm*** shortcomings of the calorimeter that you will try to avoid in your design.

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***3. Design***

Design requirements

What are the needs that must be addressed in your design?

(My calorimeter must be able to …)

System Criteria:

a. Must be SAFE and NON FLAMMABLE

b. Must be hand-held

c. Must be able to perform an experiment to measure the heat of combustion of either paraffin or ethanol running two trials and collecting data in a 55 minute block.

d. Must be made of household materials. You may not purchase a system.

e. Must stick to a budget of $10 or less.

f. Must have your design approved by your teacher.

Initial design description

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Initial design drawing

Initial Design Materials List with Cost

All materials must have a cost associated with them. This includes tape and any other small materials you may need to use. Recycled materials can have a cost of $0, you must site the source of the recycled material. For example: a nail taken from an old board in my basement would have $0 cost, one you purchase at the store would have a cost greater than this, possibly $0.25.

Material Cost

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Total Cost \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Approval from teacher \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***4. Build a working model of your calorimeter and bring it into class.***

***5. Test and Redesign***

Perform two trials with your calorimeter to measure the heat of combustion for either paraffin or ethanol. Record your data in the data table below.

|  |  |  |
| --- | --- | --- |
|  | Substance used is - | |
|  | Trial 1 | Trial 2 |
| mass of water |  |  |
| initial temp of water |  |  |
| final temp of water |  |  |
| temperature change |  |  |
| calculation of heat absorbed by the water |  |  |
| initial mass of fuel |  |  |
| final mass of fuel |  |  |
| mass of fuel burned |  |  |
| heat of combustion of fuel in kJ/ g |  |  |
| heat of combustion of fuel in kJ/ mol |  |  |

**Results**

What is your average experimental heat of fusion for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

in kJ/g \_\_\_\_\_\_\_\_\_\_\_\_\_

in kJ/mol \_\_\_\_\_\_\_\_\_\_\_\_\_

What is the theoretical heat of fusion for \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in kJ/mol? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

What was your percent error? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Did your percent error improve? Why or why not?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Redesign**

List 3-5 ways you could redesign your calorimeter, include the specific improvements that you would be looking for.

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***6. Share Solution***

**Demonstrate your calorimeter and experimental results to the class.**

What’s the best feature of your design? Why?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What were the different steps you did to get your calorimeter to work?

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What was the hardest problem to solve?

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Did you have to do something a few times to get it to work? What?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Was your design successful in decreasing your percent error by 10% or more? Explain using data, sighting actions from the activity and referencing design concepts (objects, diagrams and drawings).

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**Engineering Design Process Evaluation Rubric**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Score*** | ***4*** | ***3*** | ***2*** | ***1*** |
| ***1. Identify the problem*** |  |  |  |  |
| ***2. Brainstorm*** |  |  |  |  |
| ***3. Design Plan*** |  |  |  |  |
| ***4. Build a Working Model***  ***(Prototype)*** |  |  |  |  |
| ***5. Test and Redesign*** |  |  |  |  |
| ***6. Discuss and Share Solution*** |  |  |  |  |
| ***7. Mathematical Practice*** |  |  |  |  |

**Total Grade \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_/28pts**