

Chemistry 150

Please have the following pages ready **before** class on Wednesday, January 17. Write an **abstract** and **paper-clip** it to the front of your individual writeup. The abstract and the carbon-copy pages of the write-up are due in class on **Wednesday, January 24**.

The heat of reaction of the combustion of magnesium $\text{Mg (s)} + 1/2 \text{O}_2 \text{(g)} \rightarrow \text{MgO (s)}$ is hard to measure because, as you saw last quarter, there was a lot of heat given off in a short period of time. See the images at <http://www.webelements.com/webelements/elements/text/Mg/key.html> if you haven't seen burning magnesium. The "lot of heat" and "short period of time" make it difficult to measure the amount of heat given off using typical general chemistry lab equipment.

In fact, we are going to be sneaky and use Hess's Law to determine the heat of magnesium combustion indirectly. Go to the website:

<http://chemweb.calpoly.edu/chem/124/124Experiments/Thermochem/HessExp.html>

and look **only** at the instructions for **magnesium**. We are not using the Silberberg textbook; the equivalent is section 8.9 in the McMurry and Fay text.

Your name, your partner's name, date of experiment

Lab 2: Determination of the heat of magnesium combustion using Hess's Law

Part 1. Purpose

Please write a **sentence** or two stating the goal of this experiment, based on the information on the Cal Poly web page. Then **write** and **balance the set of four equations** found on the Cal Poly web page (#1 through #3 and the NET equation).

List the relevant mathematical equations (i.e., the derivation of kJ/mol Mg burned) that you will be using.

Part 2. Materials and methods

Chemicals needed: magnesium metal strip; magnesium oxide powder; 1 M HCl

Equipment needed: **Sketch** the setup and **label** the various pieces of equipment. Hint: this really ought to look a lot like Lab 1's setup.

Part 3. Procedure

1. Set up the apparatus, including the data logger and the laptop computer, similar to the setup of Lab 1. Remember that part of the point of Lab 1 was to determine which calorimeter setup yielded more accurate results.

2. Tare your calorimeter and pour approximately 25 mL of 1 M hydrochloric acid into the calorimeter. Record the mass down to the milligram.
3. Tear the magnesium ribbon into approximately seventy milligram or more pieces. Avoid pieces larger than one hundred and fifty milligrams. Weigh a piece to the milligram, and roll the ribbon into a very loose spiral. This is to keep the temperature probe away from the metal during the reaction.
4. Record the temperature of the hydrochloric acid in the calorimeter to be sure that it has reached thermal equilibrium with the room.
5. Carefully drop the magnesium ribbon into the calorimeter and record the temperature change until it reaches thermal equilibrium. You should be tracking this on a graph in the data logging software on the laptop.
6. Record the appearance of the solution in the cup. Note the presence, texture and color of any solid residue.
7. After thermal equilibrium is reached, pour the solution including any solid residue into the appropriate waste container. Rinse out the calorimeter and dry it as best as you can.
8. Repeat the procedure until you obtain two trials whose enthalpies of reaction (in J/g) agree to within 5% of each other.
9. Repeat the procedure for approximately 0.250 grams of magnesium oxide powder instead of the magnesium ribbon. Be sure to record the mass of the MgO to the milligram. Obtain two trials whose enthalpies of reaction (in J/g) agree to within 5% of each other.

Waste disposal — Dispose of any magnesium-containing materials in the **container designated for magnesium waste disposal** in the hood.

Part 4. Original data

Since you should end up running at least four trials total (at least two for the Mg, at least two for the MgO), a series of tables, one for each trial, that lists the **mass** of **both** reactants (identify them), the **initial temperature** (T_i), the **final temperature** (T_f) and the **temperature difference** (ΔT) for each trial. A bonus would be to list the number of seconds for T_f to be achieved. Don't forget to identify which trial number it is for each table. Include a spot for the **description** of the contents of the cup after the reaction for each.

Part 5. Calculated results

For one trial, show how you calculated the enthalpy of reaction of magnesium and HCl in J/g and kJ/mol. Then calculate a **mean** for your two "good" trials.

For one trial, show how you calculated the enthalpy of reaction of magnesium oxide and HCl in J/g and kJ/mol. Then calculate a mean for your two "good" trials.

For the two means above, show how you then calculated the enthalpy of **combustion** of magnesium ($\Delta H_{\text{combustion}}$) in kJ/mol Mg. Note that you will have to look up the $\Delta H_{\text{rxn}}^{\circ}$ for a reaction in the text's appendix.

Show the calculation of $\Delta H_{\text{reaction}}$ for $\text{Mg (s)} + 1/2 \text{O}_2 \text{(g)} \rightarrow \text{MgO (s)}$ using ΔH_f° from the textbook.

Calculate a **percent error** between your value of $\Delta H_{\text{combustion}}$ and the reference value $\Delta H_{\text{reaction}}$.

Part 6. Group results

Write your experimental magnesium combustion enthalpy on the overhead and record **all** groups' experimental magnesium combustion enthalpies. Calculate the mean and standard deviation, and comment about where your results fit in (for instance, are your results **outliers**? are there any outliers at all in the whole data set?). Finally comment on whether the class as a whole or your partnership was closer to the calculated combustion enthalpy and why this might be so.

Part 7. Questions

- How would the temperature difference be **affected** by not *fully* immersing the sensitive part of the temperature probe? Show your reasoning.
 - How would **ΔH for that reaction** be affected by the error in part a? Again, show your reasoning.
 - How would **$\Delta H_{\text{combustion}}$** be affected by the error in part a? Or can you tell without further information? Again, show your reasoning.
- How would the temperature difference be affected by the magnesium not *completely* reacting with the acid? By this, I mean: would the temperature difference of the magnesium-hydrochloric acid reaction have been greater, less or stayed the same? In any case, explain your answer in a semi-quantitative way.

Part 8. Conclusion

A sentence:

- To report your partnership's final value of **$\Delta H_{\text{combustion}}$** .
- To report the percent error between your derived **$\Delta H_{\text{combustion}}$** and the calculated value of **$\Delta H_{\text{combustion}}$** .
- To comment on the size and direction (higher or lower?) of the error and to suggest a source(s) of either systematic or random error, as appropriate.
- To suggest a "fix" for the error source(s) you named.

- To report the class's final value of $\Delta H_{\text{combustion}}$.
- Comment on whether you have more confidence in your results or the class's results.

Abstract

Again, a short (less than 100 word) summary of the major result(s) of your experiment, and the method by which you achieved this result.

Name, school affiliation, title, text as usual. What was the major result (and uncertainty)? By what method did you achieve the result — summarize this briefly? How did your result compare to published values? Is that acceptable, and do you have confidence in your methods?