Experiment: Heat of Formation of MgO IB Chem I

In this experiment, you will experimentally determine the heat of formation of magnesium oxide through calorimetry, Hess's Law, and a known ΔH_f value.

Clothing
This experiment requires proper safety attire, including close-toed shoes, long pants (NOT tight-fitting leggings), and goggles. If you are not properly attired, you will have to come back to perform the experiment during your free time.

Learning Goals
- Define the "system" and "surroundings" for an experimental setup, and track the heat change between system and surroundings.
- Use a coffee cup calorimeter and specific heat capacity to measure heat change.
- Use aqueous acids to dissolve metals.
- Use heat (q) to calculate enthalpy (ΔH) for a chemical reaction.
- Use Hess's Law to calculate ΔH for a given reaction.
- Calculate a percent difference, reporting the answer to the correct number of sig figs.

Supplemental Resources
Required reading before coming to lab: Cambridge IB Chem text: sections 5.1 & 5.2

Lab document requirements

Before lab:

- Purpose
- Balanced equations for the two reactions (A & B) you'll be performing. Include phase labels.
- Complete data table

After lab, partial formal report, on Turnitin

- Data table
- Graphs from Logger Pro
- Calculations and Analysis, clearly labeled, including all work, units & sig figs (no uncertainty required)
- Evaluation: remember to address possible sources of systematic error and how they could have led to a higher or lower experimental value of ΔH_f(MgO) than the actual.

PROCEDURE
A. Determining Heat of Reaction of Mg with HCl - Use the Fume Hood for this reaction!!

First rinse and dry your calorimeter setup (two cups, nestled together – referred to as CAL), and weigh them together to the nearest 0.01 g; record this mass in your notebook. You must use these two cups for both parts of the experiment. Then place about 100 mL of 2M (2 mol dm^{-3}) HCl into the inner cup. Weigh the CAL and HCl solution to the nearest 0.01 g and record this mass. Cover the CAL and insert the temperature probe. While this is coming to thermal

equilibrium, obtain about 0.50 g of Mg turnings and weigh them accurately to the nearest 0.01 g and record this mass.

Begin recording the temperature (set to record one data point every 5 seconds). In the fume hood, drop in the weighed magnesium, replace the cover and stir constantly until the temperature begins to decrease and decreases steadily for 10 minutes. All of the Mg should react. Save your graph. **Wash the spent reaction mixture down the sink with lots of water.**

B. Determining Heat of Reaction of MgO with HCl

You will be following the same procedure for this experiment, **EXCEPT** you will use MgO. Calculate an amount of MgO that is equimolar (equal in moles) to the amount of magnesium you used in the previous reaction. Show this calculation in your notebook and obtain instructor initials in your notebook before moving on. This reaction does not need to be in the fume hood, so you may perform the reaction at your bench. Record all data in your notebook. Place 100 mL of 2M HCl into the clean, dry, pre-weighed CAL. Weigh as before to determine mass of HCl.

Weigh the MgO on weighing paper. Record the temperature of the 2M HCl in the CAL. Add the MgO to the acid (**stirring constantly**). Record the temperature for at least 30 minutes, until the temperature has been decreasing for at least 10 minutes. Save your graph. **Wash the spent reaction mixture down the sink with lots of water and rinse and return the Styrofoam cups to the prep bench.**

Calculations/Analysis: these should each be clearly labeled in your notebook
Because the HCl is such a dilute solution, you can assume that the specific heat of the solution is the same as that of water.

For each Reaction A & Reaction B, show and label these calculations. Include uncertainty analysis:

- $\Delta T_{solution}$
- $m_{solution}$
- $q_{solution}$
- $q_{reaction}$
- $\Delta H_{reaction}$ (in kJ/mol Mg or kJ/mol MgO)

Reaction C: Look up and record ΔH_f of $H_2O(l)$ and write the corresponding balanced equation for the formation of one mole of liquid water.

Reaction D: Write the balanced equation for the formation of one mole of magnesium oxide. Use Hess's Law and Reactions A, B & C to calculate the heat of formation of MgO. Include uncertainty analysis.

Percent difference: Determine the percent difference between the actual ΔH_f of MgO and your experimental value.