Heat of Formation of MgO   Lab #27

The heat of formation of a compound is the heat required to form one mole of that compound from elements in their standard state. If the heat of formation is a positive value then the reaction requires heat to occur and is called endothermic. If the heat of formation is negative, the reaction is exothermic and releases heat.

The formation of MgO from magnesium and oxygen is extremely exothermic and is therefore difficult to measure directly. To determine this value we will use Hess' Law, which states that when one reaction can be written as the sum of two or more others, then the heat of that reaction is the sum of the heats of the other reactions.

The heat for each reaction will be measured in a calorimeter (Styrofoam cup). You will then be able to calculate heat by measuring the temperature change and using the formula $q = m c \Delta T$. For this lab, you may assume that the specific heat (c) of the solution is equal to the specific heat of water (4.18 J/g^{o}C).

Materials:
TI-83 calculator with CHEMBIO	CBL System	temperature probe
Styrofoam cup balance	Mg ribbon	MgO
1M HCl		

Procedure:
> **CAUTION:** Hydrochloric acid is corrosive. Avoid all contact with this acid. If you spill it follow the same procedure as above. Remove any affected clothing, rinse thoroughly and call your instructor.

> **Part A:**
> Find the mass of a Styrofoam cup. Add approximately 100 mL of HCl solution and reweigh the cup and solution.

> Set up the calculator, CBL and temperature probe. Run the program CHEMBIO. Set up the temperature probe using the STORED calibration, if asked. From the DATA COLLECTION menu, choose MONITOR INPUT.

> Weigh out approximately 0.5 g of magnesium ribbon. Record the exact mass of the magnesium.

> Take the cup and solution back to your desk. Put the temperature probe into the solution and wait for the temperature to stabilize. When the temperature is stable, record that temperature and then add the magnesium ribbon to the cup. Use the temperature probe to stir the solution until the magnesium has completely reacted. Record the highest temperature reached.

> Rinse the temperature probe, dump the solution and rinse out and dry the cup.

> **Part B:**
> Set up the CBL system using the same settings as before.

> Add approximately 100 mL of HCl solution to your cup and reweigh it.

> Place a piece of paper on the balance and rezero it. Carefully weigh out 1 g of MgO on the paper. Record the exact mass of the magnesium oxide.

> Take the cup and solution back to your desk. Put the temperature probe into the solution and wait for the temperature to stabilize. When the temperature is stable, record that temperature and then

add the magnesium oxide to the cup. Use the temperature probe to stir the solution until the magnesium oxide has completely reacted. Record the highest temperature reached.

Rinse the temperature probe, dump the solution and rinse out and dry the cup. Put away all equipment.

Calculations:

For each reaction, determine the mass of the solution and the change in the temperature.

Determine the heat of each reaction, then divide each heat by the moles of magnesium used in that reaction.

Determine the heat of formation of magnesium oxide, given that the heat of the reaction $H_2 + \frac{1}{2} O_2 \rightarrow H_2O$ is -285.83 kJ/mol.