microLAB

A HESS' LAW INVESTIGATION (#1.2)

The CCLI Initiative
Computers in Chemistry Laboratory Instruction

Learning Objectives

The objectives of this experiment are to ...

* measure the heats of reaction for two chemical reactions.
* use Hess's Law, in conjunction with the above measurements, to calculate the heat of reaction for the combustion of magnesium metal.

Background

The heat of reaction (ΔH) is defined as the heat lost or gained as a reaction proceeds from reactants to products. It is often given as part of a thermochemical equation, such as that shown for the combustion of hydrogen in equation 1:

$$2 H_2 (g) + O_2 (g) \rightarrow 2 H_2O (l) \qquad\qquad \Delta H = -572 \text{ kJ} \qquad (1)$$

The negative sign indicates that this reaction is exothermic. Conditions of constant atmospheric pressure (reaction vessel is an open container) and near room temperature (25 °C) are assumed in the above value, although heats of reaction do not vary appreciably with temperature.

A calorimeter is a device for measuring the heat of reaction. For reactions involving aqueous solutions, a simple styrofoam coffee cup works well. One carries out the reaction in the cup and measures the temperature change (Δt). Assuming adiabatic conditions (no heat loss), the reaction heat all goes into warming the solution *and* cup. Students are shown how this heat quantity can be calculated. Dilute solutions generally are considered to have a specific heat equal to 3.86 J/g °C and density of 1.00 g/mL. The estimated cup heat capacity is 3.0×10^1 J/°C. In this experiment students will measure ΔH values for the dissolution of Mg metal in $HCl_{(aq)}$, MgO (s) in $HCl_{(aq)}$. Using the thermochemical equations for these two reactions along with that previously given for the hydrogen/oxygen reaction (equation 1), students will then calculate the ΔH value for the combustion of magnesium by applying Hess' Law as described in your text book.

Temperature probe calibration and experiment program: The temperature probe is calibrated at a minimum of three points using mixtures of ice, tap water and hot water.

The Calorimeter: This consists of two styrofoam cups (one nested in the other for extra insulation), a styrofoam lid, a thermistor, a magnetic stir bar, and a supporting beaker.

The Mg/HCl reaction: The Mg metal is dissolved in 100 mL of 1.00 *M* HCl in the calorimeter.

The MgO/HCl reaction: The MgO is dissolved in the same manner.

Data Analysis: Guidance is given in obtaining the ΔTs from the graphs, and performing the calculations to obtain the desired results.

Instructor Resources Provided

1. Sample Report Sheets providing the format to organize the data collection with sample data.
2. Questions to consider, answer and turn-in with suggested answers.
3. Tips and Traps section to assist the instructor with potential problems and solutions.
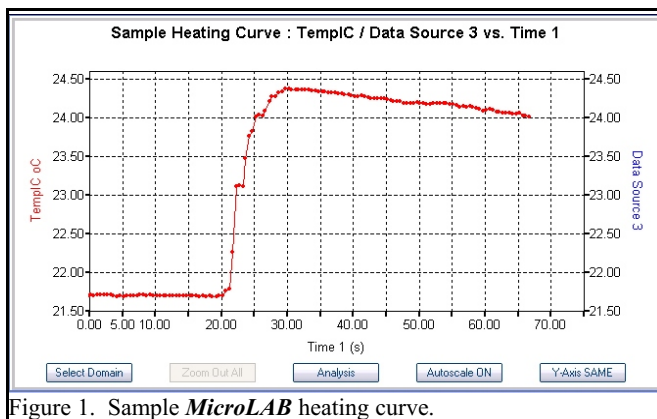4. Sample *MicroLAB* screen shots and graphs.
5. Laboratory preparation per student station.

Figure 1. Sample *MicroLAB* heating curve.