CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Ben J. Kaiser

Project Number
S0510

Project Title
Hess' Law and Thermochemistry

Abstract

Objectives/Goals

Background: Hess# law states that if a reaction can be carried out in a series of steps, the sum of the enthalpies for each step should equal the enthalpy change for the total reaction. This statement emphasizes the conservation not only of matter, but also of energy. If certain reactions are difficult to study, their enthalpy can be calculated from Hess# law.

The purpose of this experiment is to use a calorimeter with a thermometer to investigate the enthalpy changes in several different reactions. After all the data have been collected from the different reactions, the data will be analyzed in order to determine whether or not the data supports Hess# law for a reaction that is otherwise difficult to measure.

Methods/Materials

Methods: The heat capacity was first determined for the calorimeter that was to be used. The enthalpy change was then measured in several separate reactions that could eventually be added up to compare the measured and the calculated ÄH of the third reaction. Each reaction was performed 3 times and the mean was taken for the graphical data analysis.

Results

Results: The reactions R1a = HCl + NaOH --> NaCl + H2O and R2a = NH4Cl and NaOH --> NaCl + H2O + NH3 both were exothermic. The ÄH of the target reaction R3a = HCl + NH3 --> NH4Cl could be measured and calculated.

Similarly, I used R1b NaOH(s) + H2O --> Na(aq)+OH(aq) and R2b = NaOH + HCl --> H2O + Na(aq) + Cl(aq) to calculate R2b = NaOH(s) + HCl --> Na(aq) + Cl(aq) + H2O and compare it with the measured values.

Conclusions/Discussion

Hess# law is an important principle even for things in life today. Hess# Law states that if two chemical equations can algebraically be combined to give a third equation, the values of ÄH for the two equations can be combined in the same manner to give ÄH for the third equation. The experiments that were previously performed show how a reaction that is difficult to perform and measure as an experiment can be calculated based on Hess# law.

While the large scale of Hess' law could be confirmed, there was some discrepancy of the calculated enthalpy change which is thought to be caused by the loss of energy in the relatively simple calorimeter used in the experiments.

Summary Statement

Hess# law underscores the conservation of energy which is the reason why a #perpetuum mobile# (endless motion) is impossible as energy cannot be generated from nothing.

Help Received

Teachers helped with the experiments, parents helped with a statistical software to average the triplicate experiments, as well as with the practical construction of the board.