Experiment 12

[Science](), [Physics]()

Experiment 12 Calorimetry and Heat of Reactions

____ PERFORMANCE GOALS: 1. To learn how to use of a calorimeter 2. To learn how to collect and manipulate data in the computer 3. To calculate the calorimeter constant 4. To use Hess' Law to find the heat or formation of magnesium oxide CHEMICAL OVERVIEW: - Enthalphy: (Î” H) : when chemical or physical changes occur at a constant pressure. - Calorimeter: is an instrument with insulating walls where the reaction happens. Eq. 1: q rxn = -qsurrounding - Heat of capacity of the calorimeter: " Cp" must be calculated at the beginning of every calorimeter experiment in Joules/ °C Heat Capacity of the Calorimeter: The calorimeter constant is easily found by adding a fixed amount of hot water to a known amount of cold water and the change in temp for each recorded, due to the Law of Energy Conservation the amount of heat released by the hot water should be equal to the amount of heat absorbed by the cold water: Eq. 2 q released(Hot Water) = -q absorbed (Cold Water) If there is a discrepancy between these two values use the following equation: Eq. 3 q= m x spht x Î” T Where spht is the specific heat of the substance in J/ g°C Î” T is the temperature change in °C and m is the mass in grams Mass of Cold Water| 51. 20 g| Initial temperature of cold water| 20. 3 °C| Mass of hot water| 49. 82 g| Initial temp of hot water| 98. 2 °C| Final temp of the mixture| 58. 3 °C| Eq. 4 qHot = mHot x sphtWater x Î” THot qHot = (4. 184 J/ °C-g)(49. 82g)(58. 3 °C-98. 2 °C) = -8317 J Eq. 5 qCold = mCold x sphtWater x Î” TCold qCold = (4. 184 J/ °C-g)(51. 20g)(58. 3 °C-20. 3 °C) = 8142 J 8317-8142 = 175 joules Cp = (175 J) / (58. 3 °C - 20. 3 °C) Cp = 4. 6 J/ °C HEAT OF REACTIONS: q released = -q absorbed Eq. 6 q released = - (q solution + q calorimeter) Eq. 7 qSolution = mSolution x sphtWater x Î” TSolution sphtsolution= 4. 184 J/ g °C Eq. 8 q calorimeter= Cp x Î” T Eq. 9 q reaction = Î” Hreaction Hess's Law Hess's Law states that the enthalpy of a reaction is independent of the steps that it takes to get from reactants to products because enthalpy of reaction is a state function. State Function- depends on initial and final state but not on the path taken â�ƒ Temperature â�ƒ Volume â�ƒ Pressure â�ƒ Energy | Mg (s) + 1/2 O2 (g) --> MgO (s) PRE-LAB ASSIGNMENT 1. Predict the product, balance the questions and write the net ionic equations for the reactions: a. Mg (s) + HCI (aq) ---> b. MgO (s) + HC: (aq) ---> 2. Write the reaction that represents the enthalpy of formation (Î” Hfor) of water. 3. Use the table of the thermodynamic data in your text book to calculate the Î” H for each of the three reactions REMEMBER Eq. 10 (Î” H °rxn = Î£ (nÎ” H °for)prod - Î£ (nÎ” H °for)react 1) 2) 3) 4. Use Hess's Law combining the three molecular equations to calculate the Î” Hrxn for the reaction of the formation of MgO. PROCEDURE A. CALIBRATION OF THERMISTOR 1. 2. 3. 4. 5. 6. 7. B. DETERMINATION OF THE HEAT CAPACITY OF THE CALORIMETER 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. C. REACTION OF MgO AND HCI 1. 2. 3. 4. 5. 6. 7. 8. 9. D. REACTION OF Mg AND HCI 1. 2. 3. 4. 5. 6. 7. E. DATA AND CALCULATIONS A. Calorimeter Constant Mass of Styrofoam cup with lid + spin bar (g)|| Mass of cup with lid + spin bar + 50mL of room temp. water (g)|| Initial Temp of Room Temp. Water (°C)|| Initial Temp of Hot Water(°C)|| Total mass at the end (g)|| Calculated Heat released by Hot Water (J) (Eq. 4)|| Calculated Heat absorbed by R. T Water (J) Eq. 5)|| Calculated Heat absorbed by Calorimeter (J)|| Calculated Heat Capacity of the Calorimeter, Cp (J/°C) (Eq. 8) || B. Heat of Reaction of MgO Mass of weighing boat (g)|| Mass of weighing boat + Magnesium oxide (g)|| Mass of Magnesium oxide (g)|| Mass of Styrofoam cup with lid + spin bar (g)|| Mass or Styrofoam cup with lid, spin bar (g) + HCl|| Calculated Mass of HCl (g)|| Total Mass of solution at the end|| Calculated Mass of MgO (g) (using total mass of solution)|| Initial Temperature of Solution (°C) (before MgO was added)|| Final. Temp of solution (°C) (after MgO was added)|| Calculated Heat absorbed by solution (J) (Eq. 7)|| Calculated Heat absorbed by calorimeter (J) (Eq. 8)|| Calculated Total heat absorbed|| Calculated Total heat released by the solution (Eq. 6)|| Calculated Moles of MgO|| Calculated Moles of HCl|| Heat released per Mole of MgO|| Molar Heat Reaction (kJ/mol)|| C. Reaction of Mg with HCl Mass of weighing boat (g)|| Mass of weighing boat + Magnesium (g)|| Mass of Magnesium (g)|| Mass of Styrofoam cup with lid + spin bar (g)|| Mass or Styrofoam cup with lid, spin bar (g) + HCl|| Calculated Mass of HCl (g)|| Total Mass of solution at the end|| Calculated Mass of Mg (g) (using the final mass of solution)|| Initial Temperature of Solution (°C) (before Mg was added)|| Final. Temp of solution (°C) (after Mg was added)|| Calculated Heat absorbed by solution (J) (Eq. 7)|| Calculated Heat absorbed by calorimeter (J) (Eq. 8)|| Calculated Total heat absorbed|| Calculated Total heat released by the solution (Eq. 6)|| Calculated Moles of Mg|| Calculated Moles of HCl|| Heat released per Mole of Mg||