Calorimetry and hess law lab report answers

Objectives Experimental measurement of the values of two reactions \(\Delta H\) using constant pressure boilerometer technology. To use these \(\Delta H\) values in the Hess's Law calculation to determine the enthalp of metal combustion. The combustium of metal in oxygen produces the corresponding metal oxide as the only product. Such reactions are exormic and release heat. For example, iron combustion releases 1651 kJ of thermal energy for each of the four burnt iron moles: \[\ce{4Fe(s) + 3O2 (g) ->2Fe2O3 (s)} \quad \quad \Delta H_1 =-1651kJ \label{1}\] Because the enthalpy of metal combustion is difficult to measure directly, in this laboratory, it is determined indirectly by applying the Hess Thermal Summary Act. According to Hess Act, the entalpy change in the overall process is equal to the sum of entalpy changes in its individual stages. Hess legal einess \(\PageIndex{1}\): Specify \(\Delta H\) for target reaction \(\ce{2 NO2 (g) + 1/2 O2 (g) -> N2O5 (g)}\) based on the following information, \[\text{Reaction A } \quad \quad \ce{N2O5 (g) -> 2NO(g) + 3/2 O2 (g)} \quad \quad \Delta H_A =+223.7kJ \] \[\text{Reaction} \quad \ce{NO2 (g) -> NO(g) + 1/2 O2 (g)} \quad \quad \Delta H_B =-57.1kJ \] Solution reactions A and B must be carefully manipulated before they can be compressed to produce the target reaction. Reaction A must be reversed to change the character from \(\Delta H_A\). Reaction B must be multiplied by a factor of 2, in which case \(\Delta H_B\) multiplied by 2. Only then will they produce a target equation when added together: \[\ce{2NO(g) + 3/2 O2 (g) -> N2O5 (g)} \quad \Delta H=−(+223.7)=-223.7 kJ \] \[+ \quad (\ce{2NO2 (g) -> 2NO(g) + O2 (g)}) \quad\quad \Delta H=2 \times (-57.01)=-114.2 kJ \] \[\ce{2NO2 (g) + 1/2 O2 (g) -> N2O5 (g)} \quad \quad \text{Target}\] Thus\ Delta H_{\text{Target}} = -223.7 + (-114.2) = -3 37.9 kJ\) To use the Hess Act to find the combustion heat of metal, you must first obtain reaction (\(\Delta H\) values) for equations that can be properly summarized together. To achieve this, two reactions are studied in this laboratory. In one reaction, the metal reacts with hydrochloric acid and metal chloride, which produces hydrogen. In the second reaction, the corresponding metal oxide reacts with hydrochloric acid-producing water and metal chloride. For example, iron and iron (III) oxide reactions are as follows: \[ce{2Fe(s) + 6HCl(aq) -> 2FeCl3 (aq) + 3H2 (g)} \quad \quad \Delta H_2 \label{2}H_2 Se\] \[\ce{Fe2O3 (s) + 6HCl(aq) -> 2FeCl3 (aq) + 3H2O(l)} \quad \quad \Delta H_3 \label{3}\] Because both reactions are exormist, the released heat (\(q\)) is absorbed into the surrounding reaction mixture. As long as the reactions are carried out in an isolated container (such as a coffee cup heat exchange with tank walls or outdoor air is limited. By monitoring the temperature of the reaction mixture when using certain amounts of realysates, The amount of heat (J) released by these reactions can be determined using the equation: \[\text{heat released by reaction} (−q_{\text{reaction}}) = \text{heat absorbed from reaction mixture} (+q_{\text{alloy}} = (m \times c \times \Delta T)_{text{seos}}\] This \(m\) has the total mass (g), \(\Delta T\) is the maximum temperature change that occurs during the reaction (°C) and \(c\) is the mixture specific heat capacity (J/g°C). Please note that since reactions occur in the aqueous solution, it is reasonable to replace the specific thermal capacity of the water (= 4,184 J/g°C) with the specific thermal capacity of the mixture. Remember that at constant pressure (under the conditions of this experiment), the heat released by the reaction corresponds to the reaction winter: \[q_P = \Delta H\] Because the heat released by each reaction is similar to the amount of metal/metal oxide used, \(\Delta H_2\) and \(\Delta H_3\) can be easily calculated per gram or mole of the metal/metal oxide used. It should be noted that the reactions \ref{2} and \ref{3} still cannot be compressed to produce a reaction \ref{1}. Another reaction is required: \[\ce{2H2 (g) + O2 (g) -> 2H2O(l)} \quad \quad \Delta H_4 \label{4}\] \(\Delta H\) for this reaction (water formation from its elements) must be obtained from the table-like thermodynamic data in the textbook. Finally, the reactions \ref{2}, \ref{3}, and \ref{4} and their entalpies can be summed together to determine the enthalp of the combustim of metal \ref{1} provided by Hess law. Materials and Equipment \(\ce{Mg}\) (s), \(\ce{MgO}\) (s), \(\ce{Zn}\) (s), \(\ce{ZnO}\) (s), \(\ce{Al}\) (s), \(\ce{Al2O3}\) (s), 1 M \(\ce{HCl}\) (aq), 6 M \(\ce{HCl}\) (aq), coffee cup calorimeter with lid*, thermometer*, looped stirring rod*, slotted stopper*, 100-mL graduated cylinder, 50-mL beaker, utility clamp, stand, electronic balance, and wash bottle. *Products with an asterisk must be checked out of storage. During this experiment, hydrogen gas is produced. Since hydrogen is flammable, keep all heat and flames out of your reaction vein. Hydrochloric acid (\(\ce{HCl}\)) is very corrosive. If \(\ce{HCl}\) is in contact with skin or eyes, wash immediately under running water for at least 10 minutes. Sodium bicarbonate solution in wash basins can be used to neutralise and purify acid leaks. Obtaining data instead of a thermometer in some parts can use a data collection system (laptop, Vernier® interface, temperature probe® and LoggerPro software) that directly tracks temperature changes over time. Detailed instructions for setting up this system at the beginning of the laboratory cycle. Please note that your experimental procedure is still the same regardless of the temperature monitoring method. You will be assigned a certain pair of metal metal oxides for your instructor to examine. Save their identities to the report form. Note that you perform the following procedures a total of four times, twice with metal and then twice with metal oxide. The following table shows the quantities of resins used in each combination of metal and metal oxides. Note that reactions with \(\ce{Zn}\) and \(\ce{Al}\) require concentrated 6 M acid. \(\ce{Mg}\) / \(\ce{MgO}\) \(\ce{Zn}\) / \(\ce{ZnO}\) \(\ce{Al}\) / \(\ce{Al2O3}\\) 0.15 g \(\ce{ZnO}\) \(\(\ce{Al}3}\) / \(\ce{Al2O3}\) 0.15 g \0.15 g \(\ce{Al}\) (\ce{Mg}\), 25 ml 1 M \(\ce{HCl}\) 0.40 g \(\ce{Zn}\),25 ml 6 M \(\ce{HCl}\) 0.15 g \(\) ce{Al}\), 25 ml 6 M \(\ce{HCl}\) 0.25 g \(\ce{MgO}\),25 ml 1 M \(\ce{HCl}\) 0.60 g \(\ce{() ZnO}\), 25 ml 6 M \(\ce{HCl}\) 0.75 g \(\ce{Al2O3}\\), 25 ml 6 M \(\ce{HCl}\) Press blank, dry calorie meter (two nested styro ® cups). Remove it from balance, pour about 25 ml \(\ce{HCl}\) (aq) into it, and weigh it again. Save these masses to the report (difference used \(\ce{HCl}\) (aq) mass). Weigh an empty, dry 50 ml freak. Remove it from the balance, then add the recommended mass of the metal prescribed to it and weigh it again. Record these masses in your report (the difference is the mass of the metal used). Assemble the device as shown in the figure below. The thermometer (or temperature sensor) and mixing rod shall be pushed through the holes in the calorie meter cover. The bulb of the thermometer is immersed in acid, but does not touch the bottom of the calorie meter. Fasten the thermometer using a grooved stopper and utility press. Measure the temperature of the caloric meter \(\ce{HCl}\) (covered by the lid). When a heat equal value is specified, record the temperature. Next, carefully add the metal sample to the acid. Change the lid quickly and monitor the temperature change until the reaction is complete. Stir the mixture continuously with the mixing bar when the reaction occurs. Record the maximum temperature of the mixture. Note that the mixture heats up first when the reaction occurs, but then gradually cools down as the heat disappears into the environment. However, since styrome is a poor heat conductor, this cooling occurs slowly. Therefore, it is very easy for you to identify the maximum temperature. When ready, dispose of the chemical waste according to your supervisor's instructions. Then rinse the calorie meter, thermometer and mixing bar thoroughly with distilled water, dry and repeat the experiment again. After carrying out both metal tests, perform two tests using metal oxide under the same procedure. The thermometer shall be tightened by means of a grooved stopper and an electric clamp/base. You can also place nested cups in a medium-sized slew to provide additional stability. Show your work in all calculations. When 1,104 grams of ferrous metal are mixed with 26,023 g hydrochloric acid per calorie per calorie in a cup of coffee, the temperature rises from 25,2 °C to not more than 33,5 °C. The reaction is given below. \[\ce{2Fe(s) + 6 HCl(aq) -> 2FeCl3 (aq) + 3H2 (g)}\] Specify the amount of heat absorbed by the reaction mixture (as J). It is assumed that the specific thermal capacity of the mixture is the same as the specific thermal capacity of the water. How much heat (in J) was released from the reaction that happened? Is this reaction exotermic or endotermic? Is the \(\Delta H\) reaction positive or negative? Under constant pressure conditions (as in this test), the heat released by the reaction corresponds to the reaction winter,\(q_{\text{released}} =\Delta H_{\text{reaction}}\). \(\Delta H_{\text{reaction}}\) per metal gram (J/g) used as joules. \(\Delta H_{\text{reaction}}\) per kilojoule metal mole (kJ/mol). \(\Delta H_{\text{reaction}}\) against the balanced reaction equation (kJ) in kilojoules. Consider the following three reactions: \[\ce{2Fe(s) + 6HCl(aq) -> 2FeCl3 (aq) + 3H2 (g)} \quad \delta H_A\] \[\ce{Fe2O3 (s) + 6HCl(aq) -> 2FeCl3 (aq) + 3H2O(l)} \quad \quad \Delta H_B\] \[\ce{2H2 (g) + O2 (g) -> 2H2O(l)} \quad \quad \Delta H_C\] Show how these equations must be aggregated according to Hess law to specify \(\Delta H\) for iron burning (the target equation below). Also, show clearly how the values of each of the three reactions \(\Delta H\) must be manipulated to determine the enthalp of iron burning. \[\ce{4Fe(s) + 3O2 (g) -> 2Fe2O3 (s)} \quad \quad \Delta H=?\] Using table-like \(\Delta H_f^o\) values in text, Specifies the enthalpian change (kJ) that occurs when generating water from its elements: \[\[\ce{2H2 (g) + O2 (g) -> 2H2O(l)} \quad \quad \Delta H=?\] Note that this value (and equation) is used in the data analysis of this laboratory. Experimental data Metal: Experience 1 Test 2 Dry mass, empty calorie meter Calorie meter mass plus \(\ce{HCl}\) Mass \(\ce{HCl}\) Used Mass dry, empty mixer Mixed mass plus metal Used metal mass Initial temperature (balance) \(\ce{HCl}\) Final (maximum) temperature of the mixture Data analysis Write a balanced equation between the metal specified for the reaction and \(\ce{HCl}\). All balancing factors shall be integers. Fill in the table below with the results of the calculations. Test 1 Test 2 Total mass of the mixture, \(m\) Change in the temperature of the mixture, \(\Delta T\) Mixture SHC, \(c\) (use water SHC) Heat absorbed by the mixture in J Heat according to the reaction, KJ/mol \(\Delta H_ H_{rxn}\\ \ \(\Delta H_{rxn}\\ \ \Delta H_{rxn }\) as a kJ for rxn balanced in \ref{1} Average \(\Delta H_{rxn}\) in kJ Show your work in the following calculations using only your Trial 1 data: Heat absorbed by the mixture, In J, the heat released by the reaction, (\Delta H_{rxn}\) (J/g) using \(\Delta H_{rxn}\) kJ/mol of metal used \(\Delta H_{rxn}\) kJ balanced on reaction at \ref{1} Is this reaction exothmic or endotermic? What are your experimental evidence to support this? Is \(\Delta H_{rxn}\) positive or negative? Experimental data Metal oxide: Experience 1 Experience 2 Mass of dry, empty calorie meters Calorimeter mass plus \(\ce{HCl}\) Mass of mass used \(\ce{HCl}\) mass used, empty diun mass The final (maximum) temperature of the mixture Data Analysis Enter a balanced equation for the balancing tent of the specified metal oxide and \(\ce{HCl}\) reaction. All balancing factors shall be integers. Fill in the table below with the results of the calculations. Test 1 Test 2 Total mixture mass, \(m\) Change in the temperature of the mixture, \(\Delta T\) Mixture SHC, \(c\) (use water SHC) Heat absorbed by the mixture, In J, the heat released by the reaction, J \(\Delta H_{rxn}\) from the metal used in J/g \(\(\Delta H_{rxn}\) kJ/mol of used metal \(\Delta H_\rxn}\) H_{rxn}\) kJ in rxn balanced in the \ref{1} Average \(\Delta H_{rxn}\) table in kJ: You do not need to display your work in calculations performed by the table above. Entalpy of metal combustio Write a balanced equation for burning a specified metal. All balancing factors shall be integers. Use the Hess Act to determine the entalpy balance of metal combustion above. To do this, you need balanced themochemical equations for two reactions studied in this laboratory, as well as a balanced themochemical equation to form water from its elements. Clearly demonstrate how these three equations (and their reaction talpies) need to be combined in order to achieve a target combustion reaction. Use the array \(\Delta H_f^o\) values in text to calculate the theoretical value of the specified metal combustive entalp. Specify a percentage error in the value experimentally determined by the burn winter. Combustion.