Enthalpy change essay sample

Skill P – Planning

* The aim of this practical experiment is to determine the enthalpy change for this reaction by an indirect method based on Hess's Law. Both Calcium Oxide and Calcium Carbonate react readily with 2 mol dm Hydrochloric Acid solutions. The temperature changes during these reactions can be measured and the enthalpy changes calculated.

* Chemicals and apparatus:

* 250 cm measuring cylinder

* 2 mol dm Hydrochloric Acid

* 250 cm beaker

* 0 – 10 0ï¿½ C thermometer (graduations to 1ï¿½ C)

* 2. 4 – 2. 6 g of Calcium Carbonate

* 1. 3 – 1. 5 g of Calcium Oxide

* Procedure

1. Weigh out a weighing bottle containing between 2. 4 and 2. 6 g of Calcium Carbonate

2. Weigh out a weighing bottle containing between 1. 3 – 1. 5 g of Calcium Oxide

3. Using the measuring cylinder provided place 50 cm3 of 2 mol dm-3 hydrochloric acid (an excess) into a 250 cm3 glass beaker.

4. Measure the temperature of the acid using the thermometer provided.

5. Add the calcium carbonate/ calcium oxide to the acid.

6. Take the temperature again when the reaction is complete.

7. Weigh the weighing bottle.

* Before we begin the experiment we will make sure that the desk, all the instruments and apparatus are clean. We will follow the method carefully in order to get precise and reliable results.

* We will also record all the results in the table provided, in order to analyse and calculate, when the experiment will be completed.

Skill A – Analysing Evidence and Drawing Conclusions

Results:

Mass of CaCO + Weighing Bottle

15. 01 g

Mass of CaO + Weighing Bottle

15. 01g

Mass of Empty Weighing Bottle

12. 59 g

Mass of Empty Weighing Bottle

12. 59 g

Mass of CaCO used

2. 42 g

Mass of CaO used

1. 5 g

Initial Temperature of Acid

22ï¿½C

Initial Temperature of Acid

23ï¿½C

Temperature of solution after Mixing

24ï¿½C

Temperature of solution after Mixing

23ï¿½C

Temperature Change during reaction

2ï¿½C

Temperature Change during reaction

7ï¿½C

* 50 cm of 2 mol dmHCl

* Heat capacity of HCl (aq) = 4. 2 J gK {Specific heat capacity is the measure of the heat energy required to raise the temperature of a specific quantity of a substance (thus, the name " specific" heat) by certain amount, usually one Kelvin. The modern SI units for measuring specific heat capacity are the joule per gram per Kelvin (J g-1 K-1)}

* Density of HCl (aq) = 1. 0 g cm

The aim of this experiment is to determine the Enthalpy Change of a Reaction.

The enthalpy change of this reaction is difficult to measure directly but can be found by an indirect method based on Hess' law. Hess's Law of constant heat summation shows that whatever the route from given reactants to products, the overall energy change must be the same.

In this approach, calcium carbonate and calcium oxide are reacted separately with hydrochloric acid and the enthalpy changes of the two reactions are measured. These enthalpy changes are then used to calculate the enthalpy change for the decomposition of calcium carbonate using an enthalpy cycle.

When solid calcium carbonate is heated strongly, it decomposes to give calcium oxide and carbon dioxide.

{+ Endothermic reaction

– Exothermic reaction}

> (exothermic reaction)

From the table results we know that: Mass of CaCO= 2. 42 g

= 2ï¿½C

Therefore we can calculate the heat using the formula:

H= M heat capacity where: M= mass of CaCO + mass of HCl

Heat capacity = 4. 2 J gK

= 2ï¿½C

Hence, H = (2. 42 + 50) 4. 22

H= 440. 32

We have to calculate the molar heat. Therefore,

1 mole of CaCO= 40 +12 +316= 100 = KJ mole

> (exothermic reaction)

From the table results we know that: Mass of CaO = 1. 50 g

= 7ï¿½C

Therefore we can calculate the heat using the formula:

H= M heat capacity where: M= mass of CaO + mass of HCl

Heat capacity = 4. 2 J gK

= 7ï¿½C

Hence, H= (1. 50 + 50) 4. 2 7

H= 1514. 1

We have to calculate the molar heat. Therefore,

1 mole of CaO = 40 + 16 = 56 KJ mole

CaCO CaCl We can calculate based on Hess's Law. Therefore,

Hence, =

CaO = -18. 19 – (- 56. 52) = 38. 33 KJ mole

(Endothermic reaction)

Skill E – Evaluating Evidence

A balance was used fact that leads to limited accuracy, because it is open to the air and is susceptible to outside forces. The procedure was good and the mix of reactants was intimate, so we can say that the experiment were suitable.

The first reaction (CaCO) was a very slow reaction. Therefore, when reading the temperature we had to check it constantly and pick up the biggest value. The second one (CaO) was a very fast reaction, so when reading the temperature, we had to choose the first biggest value, because after that that point the temperature will decrease and the results will be anomalous.

2. 42 g of CaCO and 1. 50 g of CaO was taken with a tendency to show variation of 0. 01g. This will lead to 0. 004% error for CaCO and 0. 006% for CaO. Our results were within this value.

Limitations in the experimental procedures:

* Weigh out the chemicals – type& position – better balance

* The temperatures – carefully take all the values of the temperature and pick up the biggest one.

Because of the changing character of the temperature we might have got an anomalous result. The temperature change in the second reaction was 7 ï¿½C, which is a considerable bigger value than the temperature from the first experiment, which was only 2ï¿½C. So, because of the changing of the temperature values during the experiment we might get anomalous results.

Hence, we can say that the experiments were not very reliable, especially because of the temperature which is very hard to be measured accurately, but also because of the heat lost during the experiment. When mixing the reactants a considerable amount of heat was evolved as both of the reactions are exothermic. To improve this, we should measure the heat evolved during the two experiments and maybe try to measure the temperature more accurately, so that the errors and anomalous results will be minimized or even canceled out.

The carbonates of calcium are not normally decomposed. This requires high temperatures and produces carbon dioxide and leaves a calcium oxide. Thermal decomposition takes place when carbonates of calcium are heated in special heat resistant test-tube and break down to give carbon dioxide and calcium oxide. The experiment shows that the rate of reaction increases at higher temperatures. When a dilute acid as hydrochloric acid is added to powdered calcium carbonate, carbon dioxide is evolved. Since the carbon dioxide escapes from the reaction environments, the whole reaction losses mass. A high temperature is needed to make the left-to-right reaction take place. Reactants have less energy than products so heat is absorbed. The reaction does not start until energy is initially supplied. Once started the energy produced keeps the reaction going.

Reliability of the two experiments:

* Weight of CaCO 2. 42 0. 01g 0. 4 % error on answer => quite

reliable

* Weight of CaO 1. 50 g 0. 01g 0. 6 % error on answer=> quite

reliable

* Weight of 50 cmof 2 mol dm HCl 0. 1 cm 0. 2% error on

answer => quite reliable

The experiment could be improved by using a balance which weighs to one more decimal place. This gives:

2. 42 g 0. 001g => 0. 04% error on answer

1. 50 g 0. 001g=> 0. 06% error on answer

We should also repeat the procedure and record the values in the table at least 3 times.

The reaction takes place at a faster rate when the calcium carbonate is in a powdered form rather than as lumps, because the surface area available for the reaction with Hydrochloric Acid is much greater than in the case of lumps, allowing more collisions per second to increase in temperature increases the rate of the reaction, because the molecules move faster and have more kinetic energy which involves more energetic collision. A greater proportion of molecules exceed the activation energy at higher temperature. The reaction takes place quicker if the reactant, hydrochloric acid, is more concentrated, because there are more molecules per volume and they will exceed the activation energy. This thing applies to the first reaction which involved CaCO, and which was very slowly because it was in lumps form. So, the first experiment could be considerable improved by turning the CaCOin powdered form.

In order to find out the enthalpy change we used Hess's Law which shows that whatever the route from given reactants to products, the overall energy change must be the same. Therefore, each of the two enthalpies calculated from the two experiments count half per cent on the final conclusion.

Hence,

CaCO 2. 42 0. 01g 0. 4 % error on final conclusion + the temperature change

CaO 1. 50 g 0. 01g 0. 6 % error on final conclusion

+ the temperature change

A considerably effect on the validity of the final conclusion have the signs of the heat evolved (whether the reactions are endothermic or exothermic). The first two experiments are exothermic reactions and as the final enthalpy change has a positive value, the reaction is an endothermic one.