CHEMISTRY 101L REPORT

EXPT. 2

Aqueous Reactions Part I

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Results: Present your data in the figures and tables below.
**If you collected more data than the template tables allow, you can add more rows to any of the tables below.*

Data Table 1. Experimental Constants and Results for Ammonium chloride and Sodium carbonate reaction

	Ammonium chloride	Sodium carbonate
Mass (g)	1.026	1.036
Initial Temperature (^{o}C)	23	23
Final Temperature (^{o}C)	20.9	24
Moles (mol)	0.019181	0.009775
Change in Temperature (^{o}C)	-2.1	1
ΔT/mol (^{o}C/mol)	-109.48	102.30

Before the reactions, we had these two reactants each in solid form. For both reactions, the temperature change occurred primarily in the first 30 seconds of the reaction. After that point, the temperature remained relatively constant. During the reaction of the Ammonium chloride, temperature dropped which indicates that an endothermic reaction was occurring. During the reaction of the Sodium carbonate, the temperature increased which indicates an exothermic reaction. After the reaction, there was no solid product or remnants.

Data Table 2. Experimental Constants and Results for Sodium Bicarbonate and Citric Acid reaction

Equations	$3NaHCO_3(s) + H_3C_6H_5O_7(aq) \rightarrow Na_3C_6H_5O_7(aq) + 3CO_2(g) + 3H_2O(l)$ $3HCO_3^-(aq) + H^+(aq) + H_2C_6H_5O_7^-(aq) \rightarrow C_6H_5O_7^{3-}(aq) + 3CO_2(g) + 3H_2O(l)$
Mass (g)	3.506
Moles (mol)	0.0417
Final Temperature (^{o}C)	14.7
Initial Temperature (^{o}C)	23.4
Temperature Change (^{o}C)	-8.7
ΔT/mol (^{o}C/mol)	-208.63

Before the reaction, we had citric acid in liquid form and sodium bicarbonate as a solid, and after the reaction there was no longer any solid residue in the cup. This is because the sodium bicarbonate dissolved into the citric acid, forming another liquid, and producing the products of carbon dioxide and water. Therefore, it is expected that the products of the reaction would contain no solids. During the reaction, we could see that the temperature was going down. This indicates an endothermic reaction.

Data Table 3. Experimental Constants and Results for Magnesium metal and Hydrochloric Acid reaction

Equations	$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$ $2H^+(aq) + Mg(s) \rightarrow Mg^{2+}(aq) + H_2(g)$
Mass (g)	0.037
Moles (mol)	0.00152
Final Temperature (°C)	28.4
Initial Temperature (°C)	23.5
Temperature Change (°C)	4.9
ΔT/mol (°C/mol)	3223.68

Before the reaction, we had the Magnesium metal in solid form and the Hydrochloric acid in a solution. During the reaction, we noticed a sharp increase in temperature, indicating an exothermic reaction was taking place. After the reaction, there were no solid remnants. Therefore, it is expected that the products of the reaction would contain no solids.

Discussion:

First, it's important to define both exothermic and endothermic reactions. A reaction is exothermic if the amount of energy to break the reactants is less than the energy released when forming the products, thus, the reaction is actually releasing energy into the environment (most commonly as heat, so it is expected to see a rise in temperature). A reaction is endothermic if the amount of energy to break the reactants is greater than the energy released when forming the products, thus, the reaction is actually harnessing energy from the environment (again, most commonly as heat, so it is expected to see a fall in temperature).

We found that the Ammonium Chloride and water reaction was an endothermic, dissolution reaction. This can be seen as the final temperature (20 °C) after the reaction was 2.1°C less than the initial temperature (23 °C) before the reaction. We also observed that there were no solid products. We found that the Sodium Carbonate and water reaction was an exothermic, dissolution reaction. This can be seen as the final temperature (24 °C) after the reaction was 1°C greater than the initial temperature (23 °C) before the reaction. We also observed that there were no solid products.

We found that the Sodium Bicarbonate and Citric Acid reaction was an endothermic, acid-base reaction. This can be seen as the final temperature (14.7 °C) after the reaction was 8.7°C less than the initial temperature (23.4 °C) before the reaction. On a per-molar basis, this reaction was responsible for the highest temperature decrease (endothermic). We found that the Magnesium Metal and Hydrochloric Acid reaction was an exothermic, gas-forming reaction. This can be seen as the final temperature (28.7 °C) after the reaction was 4.9 °C greater than the initial temperature (23.5 °C) before the reaction. On a per-molar basis, this reaction was responsible for the highest temperature change overall, and the highest exothermic temperature change.

One possible sources of error is that the temperature of the system could have increased due to the stir rod by some small amount, this may lead us to conclude that a reaction was exothermic when it was not, or it may change the degree to which our reactions appeared exothermic and endothermic. Ideally, this would be controlled for somewhat by measuring the increase in temperature of some material due to the stir rod, and then accounting for this increase in the experiment, noting the thermal capacity of the reactants. Another possible source of error is the reuse of the same Styrofoam cups and beakers, which could have contaminated the reactants and thus altered the temperature change of the reaction. Additionally, random error is always possible, which means there is always a margin of error to the results.