Effect of Differing Amount of Potassium Hydroxide Being Dissolved Have on the Temperature of the Resulting Solution

Leo Chai

White Oaks Secondary School

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## Introduction

The purpose of this relationship is to find out the relationship between the temperature change and the amount of potassium hydroxide being dissolved in tap water. The amount of potassium hydroxide (g) is the independent variable and the change in temperature of the solution is the dependent variable. The reaction of dissolving potassium hydroxide is an exothermic reaction (NASA, 2019) , which will thus produce thermal energy to change the temperature of the solution due to the conservation of Enthalpy in a closed system (Borysowicz, 2011), with enthalpy being the internal energy of the substance plus the product of its pressure and volume. (NASA, 2015) Thus change in the DV will also cause change in the IV.

The temperature will be collected with a thermometer, as it provides accurate reading of the temperature in Celsius which allows the precise calculation of the change in temperature. (Goff, 2018) The amount of potassium hydroxide would need to be smaller than the stoichiometric amount in order to keep it as the limiting reagent. (Shah, 2019) Also, the temperature change for 0g of potassium hydroxide is trivially 0. Thus a range of 1 – 9 mg of Potassium hydroxide is used.

## Experiment

### Research Question

How does different amount of dissolved potassium hydroxide (g) in water affect the temperature (°C) of the resulting solution?

### Hypothesis

If the amount of dissolved potassium hydroxide is increased, then the temperature of the water will increase, because the process of potassium hydroxide dissolving in water is a exothermic reaction (NASA, 2019), which releases thermal energy during the reaction, thus increasing the temperature of the solution as the amount of potassium hydroxide used is increased.

### Variables

Table 1

*Dependent and independent variables involved in the experiment*

| Variable type | variable | Method of control / measure | Impact on result |
| --- | --- | --- | --- |
| Independent | Amount of potassium hydroxide used (g) | Weigh and mix different amount of potassium hydroxide into the solution. | Being the Independent variable, the different amount of potassium hydroxide used will directly affect the resulting temperature |
| Dependent | Temperature of the result solution | Measured with a glass thermometer placed into the solution | The temperature measured is directly compared with the amount of potassium hydroxide used to determine the relationship between the variables |
| Controlled | External temperature | Avoid contact of the solution with other mediums such as hands | External factors such as the hands of the experimenter might change the temperature of each solution by different amounts, thus creating an uncertainty when measuring the dependent variable |
| Controlled | Reaction time | Use a timer to set times for the reaction: put the thermometer in the solution after 2 minute, and take the measurement of the temperature after 3 minutes | With a set time for the substance to react, it equalizes the temperature change due to the temperature difference between the solution and the environment, and also minimizes the uncertainty of the measurement as the thermometer was placed in the solution 1 minute before the measuring takes place. |
| Controlled | Amount of water used | Use a 100ml graduated cylinder to measure a set amount of water (100ml) for each reaction | With different amount of water, the energy of the solution gained from the reaction would be needed to be spreader between different mass, thus changing the temperature by different amount as the change in energy is proportional to the change in temperature. (NASA Glenn Research Center, 2015) |

Note：Method of control do not apply to dependent variable, and is applied to dependent and controlled variables. Method of measurement applies to dependent variable.

## Data and Analysis

Table 2

### *Raw Quantitative Data Table of Temperature (°C ±0.5°C) of the Solution Before and After Dissolving Different Amounts of Potassium Hydroxide (g±0.1g) in 100mg of Tap Water*

| Amount of Potassium Hydroxide (g ±0.1g) | Initial Temperature (°C ±0.5°C) | Final Temperature (°C ±0.5°C) |
| --- | --- | --- |
| 1.00 | 20 | 21 |
| 3.00 | 20 | 23 |
| 5.00 | 20 | 25 |
| 7.00 | 21 | 28 |
| 9.00 | 21 | 30 |

Table 3

### *Qualitative Observation Table of the Solution from Different Amounts of Potassium Hydroxide (g) Dissolving in 100mg Water*

| Amount of Potassium Hydroxide (g) | Qualitative Observation |
| --- | --- |
| 1.00 | * Potassium Hydroxide disappears quickly while stirring the solution. * The solution remains clear throughout the entire process. |
| 3.00 | * Potassium Hydroxide disappears while stirring the solution but takes some time. * The solution remains clear throughout the entire process |
| 5.00 | * Potassium Hydroxide disappear while stirring the solution but takes some time. * The solution becomes foggy after a few seconds of stirring but quickly becomes clear. |
| 7.00 | * Potassium Hydroxide disappears while stirring the solution, but takes a while of time. * The solution becomes foggy after a few seconds of stirring but quickly becomes clear. |
| 9.00 | * Potassium Hydroxide disappears while stirring the solution, but takes a while of time. * The solution becomes foggy after a few seconds of stirring and takes a while to become clear. |

Table 4

### *The Change in Temperature (K) of the After Dissolving Different Amounts of Potassium Hydroxide (g) in 100ml of Tap Water*

| Amount of Potassium Hydroxide (g±0.1g) | Initial Temperature (°C±0.5°C) | Final Temperature (°C±0.5°C) | Change in Temperature (°C ±1°C) |
| --- | --- | --- | --- |
| 1.00 | 20 | 21 | 1 |
| 3.00 | 20 | 23 | 3 |
| 5.00 | 20 | 25 | 5 |
| 7.00 | 21 | 28 | 7 |
| 9.00 | 21 | 30 | 9 |

Note：The change in temperature is calculated by subtracting initial temperature from the final temperature in °C. The uncertainty is calculated by adding the absolute uncertainty of initial and final temperatures (0.5°C + 0.5°C)

Graph 1

## Conclusion

Since the line of best fit on the final graph is a linear line that intersects with the origin and fits within all the uncertainty. Furthermore, the linear line of best fit touches all the data points, showing the high accuracy and precision within the experiment. With the data having a direct relationship and a strong correlation, it thus proves the hypothesis that the change in temperature will increase as more potassium hydroxide is added into the solution with high reliability. This can be seen from the difference in change in temperature for 1g and 3g of potassium chloride: the change in temperature increases from 1°C to 3°C.

The reason for the amount of potassium chloride used in the experiment will directly affect the change in temperature is because the reaction between water and the potassium chloride is the sole reason why the temperature will change. (NASA, 2019) The reaction is an exothermic reaction, thus releasing heat to the solution. By using more potassium chloride, there are more particles reacting, thus releasing more energy. Since the enthalpy of the system is conserved, (NASA, 2015)as there are no pressure and volume changes, the internal energy of the solution will be need to be conserved, (NASA Glenn Research Center, 2015) and the energy released by the reaction will become thermal energy, thus causing the change in temperature.

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