**Dilution**

Benson Long

*Department of Chemistry and Biochemistry, Queens College – CUNY*

*CHEM 131.1, 07, Fall 2012*

*Instructor: Freida Zavrov*

**ABSTRACT**

Dilution is a process that changes the concentration of a solution through the addition of water. The solutions that were diluted to a lower concentration were sodium hydroxide (NaOH) and potassium permanganate (KMnO4). The concentrations of the solutions were determined by measuring the pH and absorbance values. The dilution of sodium hydroxide was measured with pH. The dilution of potassium permanganate was measured with absorbance values. Since both of the solutions were diluted to a lower concentration, the pH and absorbance value readings would lower with each dilution as well.

1. **INTRODUCTION**

The purpose of this experiment was to dilute solutions and measure the concentrations of the diluted solutions. Diluted solutions have different molar concentrations and are used as stock solutions to perform different experiments. Throughout the experiment, a solution will be diluted several times. Therefore, the pH or absorbance reading for the solutions should decrease with each dilution. The pH measurement is performed for sodium hydroxide because this solution is basic and adding more water or diluting it would change the number of hydrogen ions in the solution. The absorbance measurement is performed for potassium permanganate because this solution has a distinct color to it and diluting it will change its color and absorbance readings.

1. **EXPERIMENTAL**

For the first part of the experiment, a 1.0 M sodium hydroxide (NaOH) solution was diluted 3 times. The concentrations and volumes were calculated before the dilutions were performed. For the first dilution, NaOH (1.0 M) was obtained and placed into a 10 mL graduated cylinder. 2.5 mL of NaOH was mixed with 22.5 mL of H2O in the graduated cylinder and some of it was transferred to a test tube for the pH to be measured. The pH measurement was 12.1. The resulting diluted solution had a concentration of 0.10 M. For the second dilution, 0.2 mL of NaOH (0.10 M) was taken and mixed with 19.8 mL of H2O for a 20 mL solution of diluted NaOH. A 1 mL glass pipette was used to measure the 0.2 mL of NaOH. The pH of the 2nd diluted solution was 10.9. The resulting diluted solution had a concentration of 0.0010 M. For the last dilution, 0.2 of NaOH (0.0010 M) was taken from the previous solution and mixed with 19.8 mL of H2O for a new 20 mL diluted solution. A 1 mL glass pipette was used to measure the 0.2 mL of NaOH. The pH measurement of the final diluted solution of NaOH was 9.2. The resulting diluted solution had a concentration of 0.000010 M.

For the second part of the experiment, potassium permanganate (KMnO4) was diluted 4 times. The concentrations and volumes were calculated before the dilutions were performed. For the first dilution, 2.5 mL of KMnO4 (0.020 M) was obtained with a 10 mL graduated cylinder and mixed with 22.5 mL of H2O in a test tube. The 22.5 mL of H2O was measured with a 100 mL graduated cylinder. The resulting diluted solution had a concentration of 0.0020 M. For the second dilution, 1 mL of KMnO4 (0.0020 M) was mixed with 9 mL of H2O into a second test tube for a new diluted solution of 10 mL of KMnO4. The 1 mL of KMnO4 was extracted using a 1 mL glass pipette. The resulting diluted solution had a concentration of 0.00020 M. For the third dilution, 5 mL of KMnO4 (0.00020 M) was taken using a 5 mL glass pipette and mixed with 5 mL of H2O in another test tube to create a new diluted solution with a concentration of 0.0001 M. For the fourth dilution, 5 mL of KMnO4 (0.00010 M) was taken using a 5 mL glass pipette and mixed with 5 mL of H2O in a test tube. The H2O was extracted using a different 5 mL glass pipette. The final diluted solution had a concentration of 0.000050 M. For each dilution, the color of KMnO4 became lighter and clearer. The original solution was a dark purple color and with each dilution, it became pinker in color.

Each of the diluted samples had its absorbance measured using a spectrometer unit. An empty cuvette was used to calibrate the spectrometer and gloves were used to avoid putting any fingerprints on the cuvette. After the spectrometer calibrated, 3 mL of each sample was placed into the cuvette and the absorbance was measured. After each sample’s absorbance was measured, the cuvette was cleaned and dried before used for the next sample.

1. **RESULTS AND DISCUSSION**

For NaOH, the formula M1V1 = M2V2 was used to calculate the concentrations for the three diluted solutions. The concentrations were not identical because the volumes were different for each dilution even if power if dilutions were in powers of 10. Moreover, the pH measurements were not obtained accurately because of the equipment used.

For KMnO4, the same formula was used to calculate the concentration for the four diluted solutions. The concentrations were not identical because the volumes are equal but the concentrations were different. If the formula is used, you would get different concentration values from the initial concentration values.

There were instances of error that could have manipulated the data obtained from this experiment. These sources include the equipment used to obtain the pH or absorbance values and the dilutions performed. There was nothing that could have been done about the equipment. However, the errors for the dilutions performed were minimized by creating the calculations before and creating samples as close as possible to the calculations. Glass pipettes of different sizes were used to specifically measure certain amounts of chemicals and H2O used.

1. **CONCLUSION**

Dilution is used to change the concentration of a solution. This allows for many different experiments to be performed because there are different chemicals being used. However, dilution is a concept that is not only present in the lab but also in daily life. It is seen with cooking and in the hospital where glucose concentration in blood might have to be diluted. Science is an experimentation process and the results that are learned from science are applied to humans in order to create better and improved lives.

Table I. Concentration *Mc* and measured volume *Vc* of the concentrated solution, measured volume *Vw* of the water necessary for the dilution, measured volume *Vd* and concentration *Md* of the dilute solution, and pH of the dilute solution.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Mc* (M) | *Vc* (mL) | *Vw* (mL) | *Vd* (mL) | *Md* (M) | pH |
| 10 | 2.5 | 22.5 | 25 | 0.10 | 12.1 |
| 0.10 | 0.2 | 19.8 | 20 | 0.0010 | 10.9 |
| 0.0010 | 0.2 | 19.8 | 20 | 0.000010 | 9.2 |

Table II. Concentration *Mc* and measured volume *Vc* of the concentrated solution, measured volume *Vw* of the water necessary for the dilution, measured volume *Vd* and concentration *Md* of the dilute solution, and absorbance of the dilute solution.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Mc* (M) | *Vc* (mL) | *Vw* (mL) | *Vd* (mL) | *Md* (M) | Absorbance |
| 0.020 | 2.5 | 22.5 | 25 | 0.0020 | 1.838 |
| 0.0020 | 1 | 9 | 10 | 0.00020 | 0.373 |
| 0.00020 | 5 | 5 | 10 | 0.00010 | 0.154 |
| 0.00010 | 5 | 5 | 10 | 0.000050 | 0.062 |