EXPERIMENT E2

The properties of buffers

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Section 5

Group 4

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**Objectives**

* Investigate acids’ strengths and how buffers work
* Learn how to use pH meter
* Examine the difference between strong and weak acids.
* Prepare a buffer solution as required and determine its buffer capacity

**Background**

* **The Properties of Buffers**

An acid –base buffer can resist changes in its pH by containing an acidic component that can neutralize added OH- ions and a basic component that can neutralize added H+ (or H3O+) ions. The components of a buffer are usually the conjugate acid-base pair of a weak acid. Buffers only work when the amount of H+ and OH- added is much smaller than the number of acid-base components of the buffer present.

* **Preparing a Buffer**

We can use the Henderson-Hasselbalch equation to determine the correct [base]/[acid] ration and calculate the expected pH for a buffer. Then we can determine the concentrations of weak acid and the weak base to be used in the buffer. Finally, we mix the correct volume amounts of the conjugate acid-base pair to give the desired concentration.

**Introduction**

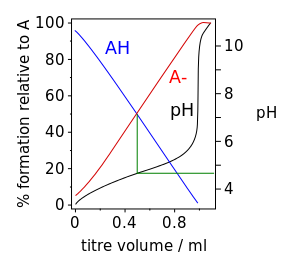
Buffers are used to lessen the impact of external force. In chemistry, the buffer to solution can resist changes in pH. For example, doctor can use buffers to restore patients’ blood pH effectively by applying their knowledge about knowledge.

**Theory**

* **Common-ion effect**

The essential feature of a buffer is that it consists of high concentrations of the acidic and basic substances, which allows the relative concentrations of the buffer components to stay about the same when small amounts of H+ or OH- ions are added to the buffer. The original component in the buffer will neutralize any added base or acid.

* **Henderson-Hasselbalch equation**

In general, the Henderson-Hasselbalch equation for any conjugate acid-base pair can be written as : pH=pKa+log([base]/[acid])

As a result, we can calculate the concentrations of acid-base ratio by knowing the target pH

**Data Processing**

**Part A**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Calibration buffer pH | 0.50M  HCl pH | 0.50M  HAc pH | Unknown  HAc pH | Mg and  HCl | Mg and  HAc |
| Expected | 4.00 | 0.3 | \ | \ | fast | slow |
| Actual | 3.99 | 1.47 | 2.58 | 2.91 | fast | slow |

**Part B**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Buffer1 | Buffer2 | Buffer3 | Buffer4 | H2O | H2O | H2O  HCl | H2O  NaOH |
| Excepted | 4.15 | 4.57 | 4.75 | 5.35 | 7.00 | 7.00 | \ | \ |
| Actual | 4.07 | 4.48 | 4.67 | 5.21 | 5.60 | 5.70 | 2.50 | 11.50 |

**Part C&D**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Buffer 1 | Buffer 2 | Buffer 3 | Buffer 4 |
| + H2O | 4.04 | 4.48 | 4.65 | 5.20 |
| +0.50M NaOH | 4.60 | 4.78 | 4.75 | 5.87 |
| +0.50M HCl | 3.81 | 4.33 | 4.56 | 5.13 |
| V(HCl) | 0.25ml | 0.35ml | 0.40ml | 0.50ml |

**Discussion**

The pH value we measured is always smaller than the expected pH value. For example, the pH of de-ionized water should be 7.00 while our results were about 5.6, which means the water is a little acidic. I think there might be some wrong with our pH meter calibration since the actual pH value of calibration buffer is also smaller. After we rinsing the electrode of our pH meter, we wipe it with dry tissue. However, the tissue might have been used before so there might be some acidic or basic substances left on it, resulting the error in our measurement. In addition, when we use the pH meter, we didn’t push the electrode deep enough, which might make the measured value approach 7 and cause error.

**Conclusion & Recommendations**

The experiment is aim at introducing some knowledge of buffers and the usage of pH meter to the students. In part A, I learn how to calibrate the pH meter and measure the pH value of unknown solution. Through part B, I used Henderson-Hasselbalch equation to calculate and make my own buffer. By observing the reaction between Mg and acidic solution, I acquired some differences between strong and weak acids. Through part C&D, I understood the buffer capacity by observing rate of change of pH value.

I hope the pH meter will be better and more accurate in the future experiments. There are some wrong with the Part D of the PLQ. The solution that we titrate is HCl while on the PLQ it’s NaOH.

**References**

Prof. T. Hamade,” The Properties of Buffers: Resisting Change in a Turbulent Word”, UM-SJTU JI & SJTU Chemistry Department