**PHYSICAL CHEMISTRY LABORATORY II**

**EXPERIMENT NUMBER: 6**

**NAME OF THE EXPERIMENT: Experimental Determination of the Reaction Rate**

**DATE OF THE EXPERIMENT:27/4/2023**

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**GROUP NUMBER: 5**

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**GROUP MEMBERS:Berkay Yapıcı & Alper İrez**

**SECTION: Thursday Afternoon**

**DATA SHEETS**

**Table 1.** Volume Titrant Added to Weak Acid Solution HCl

|  |  |
| --- | --- |
| **Volume of Volume of NaOH added (mL)** | **Conductance (S)** |
| 0 | 8,5 |
| 1 | 7,7 |
| 2 | 6,7 |
| 3 | 5,6 |
| 4 | 4,4 |
| 5 | 4,5 |
| 6 | 3,4 |
| 6,5 | 3,1 |
| 7 | 2,8 |
| 7,5 | 2,5 |
| 8 | 2,1 |
| 8,5 | 1,9 |
| 9 | 1,7 |
| 10 | 1,9 |
| 11 | 2,2 |
| 12 | 2,4 |
| 13 | 2,7 |
| 14 | 2,9 |

**Table 2.** Volume Titrant Added to Weak Acid Solution CH3COOH.

|  |  |  |  |
| --- | --- | --- | --- |
| **VNaOH** | **conductance mS** | **VNaOH2** | **conductance mS3** |
| 0 | 0,2 | 2 | 0,5 |
| 0,05 | 0,2 | 2,2 | 0,5 |
| 0,1 | 0,2 | 2,4 | 0,5 |
| 0,15 | 0,2 | 2,6 | 0,6 |
| 0,2 | 0,2 | 2,8 | 0,6 |
| 0,25 | 0,2 | 3 | 0,6 |
| 0,3 | 0,3 | 3,2 | 0,7 |
| 0,35 | 0,3 | 3,4 | 0,8 |
| 0,4 | 0,3 | 3,6 | 0,9 |
| 0,6 | 0,3 | 3,8 | 1 |
| 0,8 | 0,3 | 4 | 1,1 |
| 1 | 0,4 | 4,2 | 1,2 |
| 1,2 | 0,4 | 4,4 | 1,3 |
| 1,4 | 0,4 | 4,6 | 1,4 |

**Table 3.**Volume Titrant Added To Mixture Of Weak Acid And Strong Acid Solution

|  |  |  |  |
| --- | --- | --- | --- |
| **VNaOH** | **conductance mS** | **VNaOH2** | **conductance mS3** |
| 0,5 | 3,8 | 6,5 | 1,4 |
| 1 | 3,6 | 7 | 1,5 |
| 1,5 | 3,2 | 7,5 | 1,6 |
| 2 | 2,8 | 8 | 1,8 |
| 2,5 | 2,4 | 8,5 | 2 |
| 3 | 2,1 | 9 | 2,1 |
| 3,5 | 1,8 | 9,5 | 2,3 |
| 4 | 1,5 | 10 | 2,4 |
| 4,2 | 1,2 | 10,5 | 2,5 |
| 4,4 | 1,1 | 11 | 2,6 |
| 4,6 | 1,1 | 11,5 | 2,7 |
| 4,8 | 1,2 | 12 | 2,9 |
| 5 | 1,2 | 12,5 | 3,1 |
| 5,2 | 1,2 | 13 | 3,2 |
| 5,4 | 1,3 | 13,5 | 3,3 |
| 5,6 | 1,3 | 14 | 3,4 |
| 5,8 | 1,3 | 14,5 | 3,5 |
| 6 | 1,4 | 15 | 3,6 |
| 6,5 | 1,4 | 15,5 | 3,8 |

**CALCULATIONS**

**1)**

**Graph 1**. Volume Of NaOH Added to Strong Acid Solution HCl vs Conductance Graph

**Graph 2.** Volume Of NaOH Added to Weak Acid Solution vs Conductance Graph

**Graph 3.** Volume Titrant Added to Mixture of Weak Acid And Strong Acid Solution Graph

*End points for strong acid -NaOH titration*

**MHCl x VHCl = MNaOH x VNaOH**

VNaOH = (20 mL x 0.02 M ) / 0,05 M = 8 mL (theo)

*9 mL is exp. Value*

= 11.1%

*End points for Weak acid -NaOH titration*

**MCH3COOH x VCH3COOH = MNaOH x VNaOH**

VNaOH = (20 mL x 0.02 M ) / 0,05 M = 8 mL =theoretical value 3 mL is experimental Value

= -62.5%

*End points for weak strong acid-NaOH titration*

**MHCl x VHCl = MNaOH x VNaOH** *VNaOH = 4 mL*

**MCH3COOH x VCH3COOH = MNaOH x VNaOH** *VNaOH = 8 mL*

*1st end point 4.4 mL*

*2nd end point 6.5 mL*  **= 10% 1st end point**

**= -18.8% 2nd end point**

**QUESTIONS**

1. The errors data obtained from the experiment results from obtaining experimental data that is lower or higher than the theoretical data. The temperature is not optimum for the experimental conditions; the thermal equilibrium of the water bath may have caused these errors. The fact that it was not mixed or watched may also have caused errors.
2. When the *strong acid-strong base conductometric titration graph* is examined, it is seen that the graph curve decreases until the end point is increased because the amount of base added is excessive. The slopes of the curves are different since adding base on acid affects the conductivity of the solution. HCl and NaOH were used in the titration, and neutralization was not achieved. Theoretical As a matter of fact, hydrogen ions have more conductivity than sodium ions, and this theory has been proven by the observations obtained in the experiment. This is why when NaOH is added to the HCl solution, the conductivity increases first and then after the endpoint. Region A in Figure 1 is where the HCl ions are located and, therefore, acidic. B After the point, the C region has a basic feature because it is where NaOH ions are located. [2]

**Figure 1.** Strong Acid- Strong Base Conductimetric Titration Curve

Diagram

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*The curve of the weak acid-strong base conductometric titration graph* rises to the endpoint and then increases with a different slope. The reason for this is that the conductivity is low at first and then increases slowly and in a controlled manner. In the experiment, it was observed that the conductivity increased rapidly and sharply because of the addition of NaOH to the weak acid acetic acid after the endpoint. Ion is one of the reasons for this situation. This observation is also clearly observed in Figure 2. The area on the right after the endpoint is the region where OH ions are located. [2]

**Figure 2.** Weak Acid- Strong Base Conductimetric Titration Curve

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The two end points are seen in the weak acid-strong acid-strong base conductimetric titration graph. The first end point is formed by the strong acid HCl and the strong base NaOH. The second end point is formed because of the presence of weak acid acetic acid. The conductivity decreases with the presence of acid, but the graph curve rises again with the presence of NaOH. Figure 3 shows this information. [2]

**Figure 3.** Weak Acid- Strong Acid- Strong Base Conductimetric Titration Curve

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In *the precipitation titration* graph, it is observed that barium sulfate precipitates in the titration of magnesium sulfate with barium hydroxide. Mg+2 and SO4-2 ions are in the solution when the titration is started. When it comes to the endpoint, the conductivity drops to zero as a result of replacing all ions with the precipitate, and an increase in conductivity is observed with the addition of Ba(OH)2. [2]

**Figure 4.** Precipitation Titration Conductimetric Titration Curve

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1. Conductivity titrations have advantages because they can be used for weak acids and solutions with high dilution are suitable. End point can be observed more accurately with this titration.[1]
2. Since ions are easy to dissociate and their sizes are small, diffusion coefficients in liquids or solutions are high; they can diffuse quickly. In this case, it has been observed that their conductivity is higher than other ions.[1]

**DISCUSSION**

The purpose of this experiment is to find the end points with the help of HCl-NaOH, CH3COOH-NaOH and HCl-CH3COOH-NaOH titrations with the conductumetric titration method. By using NaOH as a titrant, the chenge in conductivity is observed when NaOH is added to strong acids. Temperature, sizes and types of ions and Concentration affects conductivity. In the experiment, the conductivity of the titrant and the effect of titration on the solutions were observed. At the same time, the effect of increasing the solution volume because of titration on the conductivity could be observed.

**REFERENCES**

[1]Atkins, P. W., & Paula, J. de. (2006). *Physical Chemistry*. Oxford university press.

[2] Khopkar, S. M. (2012). *Basic concepts of Analytical Chemistry*. Human Sciences Press.