Experiment: What is the Relationship Between Acid Concentration and % Dissociation

Purpose

Determine percent dissociation of acetic acid in various concentrations and the relationship between concentration and percent dissociation.

Introduction

Weak acids dissociate in aqueous solution to achieve equilibrium. The percent dissociation is defined as follows:

\[
\text{Percent dissociation} = \frac{\text{amount dissociated (mol/L)}}{\text{initial concentration (mol/L)}} \times 100\%
\]

For example,

\[
\text{HC}_2\text{H}_3\text{O}_2 (aq) \rightarrow \text{H}^+ (aq) + \text{C}_2\text{H}_3\text{O}_2^- (aq)
\]

The equilibrium expression is:

\[
K_a = 1.8 \times 10^{-5} = [\text{H}^+][\text{C}_2\text{H}_3\text{O}_2^-] / [\text{HC}_2\text{H}_3\text{O}_2]
\]

Since acetic acid is a much stronger acid than water \((K_w=1.0 \times 10^{-14})\), essentially all the H\(^+\) comes from acetic acid, the contribution from water is negligible. That means the concentrations of hydrogen ion and acetate ion are equal, since acetic acid is the source of both. The hydrogen ion concentration can be determined by measuring pH, then used to calculate the percent dissociation:

\[
\text{Percent dissociation} = \frac{[\text{H}^+ (\text{equil})]}{[\text{HC}_2\text{H}_3\text{O}_2] (\text{initial})}
\]

Materials and methods

Make a list, as usual. Some things will be needed, but not specifically mentioned in the procedure, such as glassware. You might want to leave some space to add items you didn’t think of beforehand but that you needed during the experiment.

Procedure

Calibrate the pH meter using the buffers provided and following the directions on the laminated sheet in the pH meter’s tray.

Measure pH of 5 acetic acid solutions of various concentrations, 0.10M, 0.50M, 1.00M, 3.00M, 6.00M.
**Data Table**

For your measured values.

**Analysis**

1. Determine the experimental % dissociation for each solution.

2. For each solution, draw an ICE table and determine the theoretical percent dissociation.

3. For each solution, determine the absolute error and percent error, using your theoretical values as the true values.

4. Organize all these calculated values in a data table.

**Conclusion**

In your conclusion you should state the experimental value of the least concentrated solution, with it’s percent error and describe the relationship between concentration and percent dissociation as specifically as the data allows. This should be in the form "As the concentration of acetic acid increases, the percent dissociation...". Make a similar statement about how the percent error changes as the concentration increases and offer an explanation for the trend.

The entire conclusion should be brief, only three or four sentences. It should also be in text, with no tables and no formulas.