Acid Dissociation Constant, K_a

Acetic acid, $HC_2H_3O_2$, is a weak acid that dissociates according to this equation:

$$HC_2H_3O_2(aq) \rightarrow H^+(aq) + C_2H_3O_2^-(aq)$$

In this experiment, you will experimentally determine the dissociation constant, K_a, for acetic acid, starting with solutions of different initial concentrations.

OBJECTIVES

- Gain experience mixing solutions of specified concentration.
- Experimentally determine the dissociation constant, K_a, of an acid.
- Investigate the effect of initial solution concentration on the equilibrium constant.

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis app
Vernier data-collection interface
pH Sensor
Stir Station and magnetic stirring bar
Electrode Support
100 mL beaker
100 mL volumetric flask
2.00 M $HC_2H_3O_2$
wash bottle
distilled water
pipets
pipet bulb

PRE-LAB

1. Write the equilibrium constant expression, K_a, for the dissociation of acetic acid, $HC_2H_3O_2$. (Use Box 3 in the Data and Calculations table.)

2. You have been assigned two different $HC_2H_3O_2$ solution concentrations by your teacher. Determine the volume, in mL, of 2.00 M $HC_2H_3O_2$ required to prepare each. (Show your calculations and answers in Space 4 of the Data and Calculations table.)

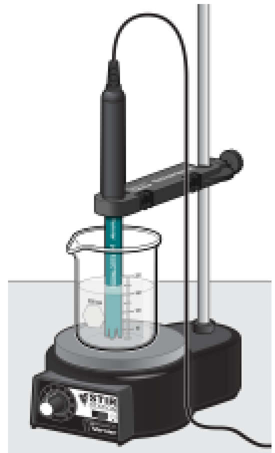

Figure 1

PROCEDURE

1. Obtain and wear safety goggles.

2. Connect the pH Sensor to the data-collection interface, and then connect the interface to your Chromebook, computer, or mobile device. Launch Graphical Analysis.

3. Put approximately 50 mL of distilled water into a 100 mL volumetric flask.

4. Use a pipet bulb (or pipet pump) to pipet the required volume of 2.00 M acetic acid (calculated in Pre-Lab Step 2) into the volumetric flask. **WARNING**: *Acetic acid solution,* CH_3COOH: *Causes skin and eye irritation*. Fill the flask with distilled water to the 100 mL mark. To prevent overshooting the mark, use a wash bottle filled with distilled water for the last few mL. Mix thoroughly.

5. Use an Electrode Support to secure the pH Sensor to a Stir Station as shown in Figure 1.

6. Determine the pH of your solution as follows:

   a. Use about 40 mL of distilled water in a 100 mL beaker to rinse the electrode.
   b. Pour about 30 mL of your solution into a clean 100 mL beaker and use it to thoroughly rinse the electrode.
   c. Repeat the previous step by rinsing with a second 30 mL portion of your solution.
   d. Use the remaining 40 mL portion to determine pH. Add a magnetic stirring bar to the solution and adjust the Stir Station so the solution is being stirred vigorously but is not splashing. (**Note**: Readings may drift without proper stirring!) When the reading stabilized, record the pH reading in your data table.
   e. When done, place the pH Sensor in distilled water.
   f. Discard the acetic acid solution as directed by your teacher.

7. Repeat Steps 3–6 for your second assigned solution.

8. When you are finished, rinse the probe with distilled water and return it to the sensor soaking solution.

PROCESSING THE DATA

1. Use a scientific calculator to determine the $[H^+]_{eq}$ from the pH values for each solution.
2. Use the obtained value for $[H^+]$eq and the equation:

$$HC_2H_3O_2(aq) \rightarrow H^+(aq) + C_2H_3O_2^-(aq)$$

   to determine $[C_2H_3O_2^-]_{eq}$ and $[HC_2H_3O_2]_{eq}$.

3. Substitute these calculated concentrations into the K_a expression you wrote in Step 1 of the Pre-Lab.
4. Compare your results with those of other students. What effect does initial $HC_2H_3O_2$ concentration seem to have on K_a?

DATA AND CALCULATIONS

1. Assigned concentration	M	M
2. Measured pH		

3. K_a expression		
4. Volume of 2 M acetic acid	mL	mL
5. $[H^+]_{eq}$	M	M
6. $[C_2H_3O_2^-]_{eq}$	M	M
7. $[HC_2H_3O_2]_{eq}$	M	M
8. K_a calculation		