Acid Dissociation Constant, K_a

In this experiment you will:

- 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.

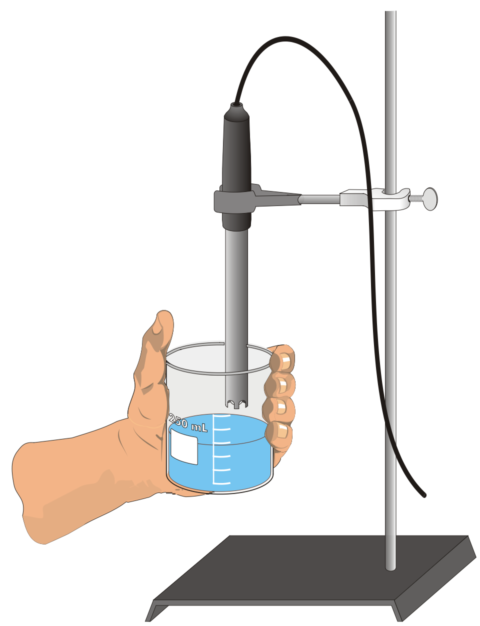
The acid to be used is acetic acid, $HC_2H_3O_2$, and its dissociation equation is:

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

MATERIALS

LabQuest	wash bottle
pH Sensor	distilled water
100-mL beaker	100-mL graduated cylinder
1.00 M $HC_2H_3O_2$	pipets
	pipet bulb

Figure 1



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 of this experiment.)

2. You have to prepare 100 mL of two different $HC_2H_3O_2$ solution concentrations – 0.10 M and 0.25 M. Determine the volume, in mL, of 1.00 M $HC_2H_3O_2$ required to prepare each. (Show your calculations and answers in Space 4 of the Data and Calculations table.)

PROCEDURE

1. Obtain and wear safety goggles.

2. Plug the pH sensor into the LabQuest. Do not remove the probe tip from its storage solution until you are ready to use it.

4. Set up the LabQuest interface for the pH Sensor.

5. Put approximately 50 mL of distilled water into a 100-mL graduated cylinder.

6. Use a pipet bulb (or pipet pump) to pipet the required volume of 1.00 M acetic acid (calculated in Pre-Lab Step 2) into the graduated cylinder. **CAUTION:** *Use care when handling the acetic acid. It can cause painful burns if it comes in contact with your skin or gets into your eyes.* Fill the cylinder 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.

7. Use a utility clamp to secure the pH Sensor to a ring stand as shown in Figure 1.

8. 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. Swirl the solution vigorously. **Note:** Readings may drift without proper swirling! When the pH reading displayed on the LabQuest stabilizes, record the pH value in your data table (round to the nearest 0.01 pH unit).
   e. When done, place the pH Sensor in distilled water.
   f. Discard the acetic acid solution as directed by your teacher.
9. Repeat Steps 5-8 for your second assigned solution.
10. When you are done, rinse the probe with distilled water and return it to the sensor soaking solution.

PROCESSING THE DATA

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

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

   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 TABLE

1. Assigned concentration	M	M
2. Measured pH		
3. K_a expression		
4. Volume of 1 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		