DATE: NAME: CLASS:

CHAPTER 17	Investigation 17.A: Determining K_a for Ethanoic Acid	BLM 17.3.2
HANDOUT		

To find the concentration of an acid in a titration experiment, you can use a pipette to place a known volume of the acid into an Erlenmeyer flask and then add a few drops of an indicator to the flask. Next, you can use a burette to add a basic solution with known concentration to the Erlenmeyer flask until the indicator changes colour. In this investigation, you will be given a sample of ethanoic acid with an unknown concentration. You will measure the pH of the solution using pH paper or a pH meter if one is available. Then you will perform a titration experiment to find the molar concentration of the ethanoic acid solution. Using this data, you will calculate K_a for ethanoic acid and find the percentage of ethanoic acid molecules that ionized in the solution.

Question

What is the acid ionization constant of ethanoic acid? What percentage of its molecules ionize in an aqueous solution?

Prediction

Predict the value of K_a and the percent ionization of $CH_3COOH(aq)$.

Safety Precautions

- Sodium hydroxide is toxic and is harmful if swallowed or inhaled. Both ethanoic acid and sodium hydroxide are corrosive. Immediately wash any spills on your skin or clothing with plenty of cool water and inform your teacher. Also inform your teacher immediately if you spill sodium hydroxide or ethanoic acid on the lab bench or floor.
- Phenolphthalein solution may irritate skin, eyes, and mucous membranes. This solution is flammable. Keep away from open flames.
- Wash your hands when you have completed the investigation.

Materials

- unknown concentration ethanoic acid solution, $CH_3COOH(aq)$
- known concentration sodium hydroxide solution, NaOH(aq)
- dropper bottle containing phenolphthalein
- distilled water
- 10 mL pipette
- labels
- 100 mL beakers (2)
- pH meter or pH paper
- 250 mL beaker for waste solutions
- burette and burette clamp
- retort stand
- meniscus reader
- funnel
- pipette bulb or pipette pump
- 150 mL Erlenmeyer flask
- sheet of white paper

Investigation 17.A: Determining K_a for Ethanoic Acid (continued)

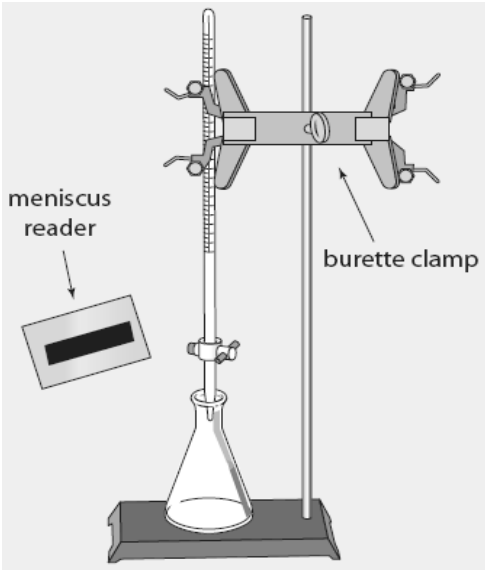
Procedure

1. Your teacher will give you the concentration of NaOH(aq). Record this concentration, as well as the volume of the pipette. Design a table to record your titration data.

2. Label a clean, dry 100 mL beaker for each liquid. Obtain about 40 mL of ethanoic acid and approximately 70 mL of NaOH(aq).

3. Measure the pH of the ethanoic acid solution using pH paper, or a pH meter if one is available. Record this value.

4. Rinse a clean burette with about 10 mL of NaOH(aq). Discard the rinse into the 250 mL beaker. Then set up a retort stand, burette clamp, meniscus reader, and funnel. Fill the burette with NaOH(aq). Make sure that the solution fills the tube below the burette tap and contains no air bubbles. Remove the funnel.



Investigation 17.A: Determining K_a for Ethanoic Acid (continued)

5. Obtain a clean 10 mL pipette and a suction bulb or pipette pump. Rinse the pipette with a few mL of $CH_3COOH(aq)$ and discard the rinse. Pipette 10.00 mL of $CH_3COOH(aq)$ into the Erlenmeyer flask. Add two or three drops of phenolphthalein indicator. Place a sheet of white paper under the flask.

6. Perform the titration. The endpoint is a faint pink colour that remains after swirling the contents of the Erlenmeyer flask for at least ten seconds. Measure the volume of base required to reach the endpoint. Repeat the titration as time permits until you have at least two sets of data that agree with each other within 2%.

7. Discard waste liquids into the beaker you have been using for this purpose. Give the beaker containing waste liquids from your experiments to your teacher for safe disposal.

8. Rinse the pipette and burette with distilled water. Leave the burette tap open and store the burette upside down.

Analysis

1. Write the chemical equation for the neutralization reaction you performed.

2. Calculate the molar concentration of the ethanoic acid, $[CH_3COOH(aq)]$. Use the ratio in which the acid and base react, determined from the chemical equation.

3. Calculate $[H_3O^+(aq)]$ using your measurement of the pH of the ethanoic acid solution.

4. Write the expression for K_a, the ionization constant of ethanoic acid in water.

Investigation 17.A: Determining K_a for Ethanoic Acid (continued)

5. Set up an ICE table and substitute equilibrium concentrations into your expression for K_a. Calculate the value of K_a and the percentage of ethanoic acid molecules that ionized in solution.

Conclusion

6. Calculate the percentage difference between your value for K_a of ethanoic acid and the accepted value. State two sources of error that might account for any differences.

Investigation 17.A: Determining K_a for Ethanoic Acid (continued)

7. Compare your value for K_a and the percentage of ethanoic acid molecules that ionized with the values determined by others in your class. Discuss the results.

Application

8. Do the values you calculated for $[H_3O^+(aq)]$ and $[CH_3COOH(aq)]$ demonstrate that ethanoic acid is a weak acid? Explain.