Titration 2: CH_3COOH Titrated with NaOH

Titration 1: Acid is CH_3COOH, phenolphthalein as the indicator

1. Obtain about 60 mL of the standardized (≈ 0.1 M) NaOH solution. **CAUTION:** *Sodium hydroxide solution is caustic.*
Avoid spilling it on your skin or clothing. Rinse with water if it comes in contact with skin or clothing.

2. Obtain a 50-mL buret and rinse the buret with a few mL of the NaOH solution. Fill the buret to above the 0.00-mL mark then drain to the 0.00-mL mark.

3. Obtain about 30 mL of the ≈ 0.1 M acid solution. **CAUTION:** *Avoid spilling the acid on your skin or clothing. Rinse with water if it comes in contact with skin or clothing.*

4. Pipet 25.00 mL of the acid solution into a clean, dry 250-mL beaker.
   - Add two to three drops of the assigned indicator.
   - Use a utility clamp to suspend the pH electrode on a ring stand as shown n Figure 1. Situate the pH electrode in the acid solution and adjust its position toward the outside of the beaker so that the stirring bar does not strike it.
   - Turn on the magnetic stirrer

5. Set up the PASCO software and hardware as directed in pre-lab. Make sure you can see the graph and table during the titration

6. Press the START button to begin recording and titrate until the end point is reached

Record the volume, pH and indicator color in your notebook.
• Continue adding NaOH solution until the buret reaches the 50.00 ml mark. **Do not go below this mark!**

8. Press STOP to stop when you have finished collecting data. Examine the data points along the displayed graph of pH vs. time.

9. Print the graph as you will need it to complete this lab.

10. Continue with DATA ANALYSIS and POSTLAB

Clean-up
1. Collect all rinse, left over and titrated solutions in a 600-mL beaker and discard in the appropriately labeled waste container.

2. Rinse the pH electrode, place it back in its storage solution.

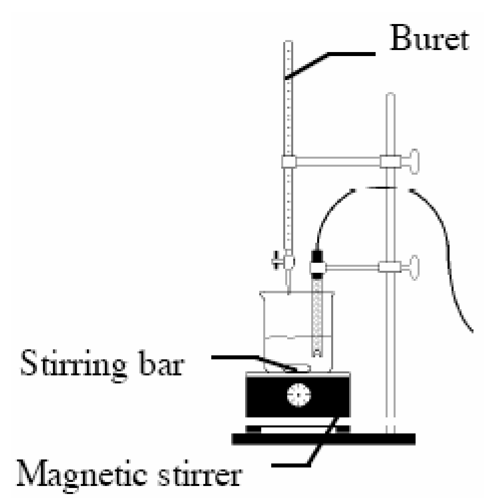

Figure 1

DATA ANALYSIS
Titration #2 CH_3COOH with NaOH

Titration 2: $CH_3COOH(aq)$ Titrated with NaOH(aq)

1. Mathematically, the equivalence point of this titration occurs at the inflection point of the titration curve. We will assume that the inflection point occurs at the midpoint of the region where the pH change is the greatest as the base is added. Using the titration curve, determine the equivalence volume of NaOH and the pH at the equivalence point. This occurs at a pH above 7.00 since this is a weak acid–strong base titration. **Clearly mark and label the equivalence point on the graph.**

Record the volume of NaOH used to reach the equivalence point.________
Record the pH at the equivalence point.________

2. Using the equivalence volume of NaOH and precise molarity of NaOH, calculate the precise molarity of the acetic acid solution you titrated.

Precise molarity of CH_3COOH ____________

Determination of Ka for acetic acid. Three methods.

1. **From the initial pH:**
Using the pH of the acetic acid before addition of any base and the calculated concentration of the acetic acid solution, determine Ka. (Look at the actual data in graphical analysis to get pH at 0.00 mL for this, do not just estimate it from your printed graph!) Determine and report the percent error in this value.

Calculated Ka from initial pH _____________
Percent Error ____________

2. From the pH at one-half the equivalence point volume:

For a weak acid titrated with a strong base, the pH at one-half the equivalence point volume is related, in a very simple way, to pKa of the weak acid. In the space below, derive the mathematical relationship between pH and pKa at this point. (HINT: Use the Henderson-Hasselbalch equation.)

a) Using your graph, determine the pH at one-half the equivalence volume. **Clearly mark and label this point on the graph.**

pH at one-half the equivalence volume _________

b) From the pH at one-half the equivalence volume, determine Ka for acetic acid. Determine and report the percent error in this value.

Ka for acetic acid from pH at half-equivalence point volume ________

Percent Error ________

3. From the pH at the equivalence point:

At the equivalence point all the acetic acid has been neutralized. The solution now contains the product of the neutralization, sodium acetate. This is a basic salt. Hydrolysis occurs so the pH at the equivalence point rises above 7. The extent of hydrolysis will determine the pH. (Make sure you understand this!)

a. Using the total volume of solution (NaOH + acetic acid) calculate the concentration of acetate ions produced at the equivalence point.

Concentration of acetate ions at equivalence point ________

b) At the equivalence point, equimolar amounts of acetic acid and sodium hydroxide have been mixed, yielding a solution of sodium acetate. The acetate ion undergoes hydrolysis, producing a basic solution. Write the hydrolysis reaction for the acetate ion.

c) From the pH at the equivalence point calculate Kb for the acetate ion.

Kb for the acetate ion ____________

d) From Kb determine Ka for acetic acid. Report the percent error in this value.

Ka for acetic acid from equivalence point pH ___________

Percent Error ___________

4. Of your three Ka values:

a. Which one is the least accurate?
b. Which one is the most accurate? Can you explain why?

5. Based upon our results, is

a. phenolphthalein a good indicator for this titration?
b. bromthymol blue a good indicator for this titration?
c. methyl red a good indicator for this titration?