WST

Name: ____________________

Partner's Name(s): ____________________

Lab Date: __________ Lab Instructor Name: ____________________

WEAK ACID AND STRONG BASE TITRATION
LAB NOTEBOOK PAGES

All purpose, procedure(s), and data/observations must be recorded in the lab notebook in pen with permanent, waterproof ink (black or blue). Pencils, markers, highlighters, and correction fluid (white-out) are not permitted. No information can be recorded elsewhere and transferred after leaving the lab. Lab notebooks can be digital or paper; you may write directly on the lab notebook pages in your lab manual or download a digital copy onto your electronic device and then write in it. Refer to the Guide for Success in the General Chemistry Laboratory section in the front of this lab manual for more detailed instructions.

- **Before Lab:** Make sure to complete the Purpose and Procedure sections in your lab notebook pages.
- **After Lab:** Upload your notebook pages to the appropriate Carmen assignment within 48 hours after the start time of your in-person lab session. If you used the notebook pages in your paper copy of your lab manual, you should scan or take photos of the pages. Do not remove them from your lab manual. Refer to the WST Notebook upload assignment in Carmen for more detailed instructions.

PURPOSE

Describe the what, why, and how of the experiment in bullet points or a few sentences. Consult the Expected Learning Outcomes and the procedure for the experiment to develop the purpose.

PROCEDURE CITATION

Chemistry 1220: General Chemistry Laboratory Manual, Fall 2025–Summer 2026.; Weaver, T. A., Opoku-Agyeman, B., Fontes N. Da Silva, C., Welch, A. N., Stern, J. E., Wroblewski, R. A., Walter, C., van Helmond, A. Eds.; Van-Griner Learning: Cincinnati, OHH; pp. 157–162.

PROCEDURE

PART A. SETUP OF pH METER, BURET, AND REACTION BEAKER

Write a summary or step-by-step procedure for this part of the experiment in the space below.

PART B. PERFORM TITRATION

Write a summary or step-by-step procedure for this part of the experiment in the space below.

CLEAN UP AND WASTE DISPOSAL

All solutions may be rinsed down the drain with a large amount of running water. Be careful to not rinse the stir bar down the drain. Notify your lab instructor if this happens. Return your stir bar, pH meter, probe, hot plate, and cable. Be sure your electrode is returned to a test tube containing storage solution. If more storage solution is needed, notify your lab instructor. After cleaning up, wipe down your work area with 70% ethanol spray and a paper towel. Wash your hands thoroughly after completing this experiment.

DATA AND OBSERVATIONS

Weak acid assigned by lab instructor ______________

Volume of weak acid used (mL) ______________

Concentration of standardized weak acid (M) ______________

Concentration of standardized NaOH (M) ______________

Write a balanced chemical equation, including phases, for the reaction of your weak acid with the provided strong base.

Calculate the moles of weak acid present in your 40.00 mL sample.

How many moles of base are needed to reach the equivalence point?

What volume of base is needed to reach the equivalence point?

PART B. PERFORM TITRATION

Initial pH of acid ______________

Initial buret reading (mL) ______________

LabRight group code ______________

Titration data.

TABLE WST.1

BURET READING (mL)	pH	BURET READING (mL)	pH	BURET READING (mL)	pH

Show your work for all calculations. Be sure all values have units and correct significant figures (see Appendix D).

TABLE WST.2

BURET READING (mL)	pH	BURET READING (mL)	pH	BURET READING (mL)	pH

REGION 1: ANALYSIS OF THE INITIAL WEAK ACID

Unlike a strong acid, a weak acid only partially dissociates in water. The acid and its conjugate base are in equilibrium, as described by its K_a value.

Write a balanced chemical equation, including phases, describing what happens when your weak acid is added to water.

Calculate the pH of your initial weak acid solution. **Be sure to show your work.**

Hint: Use an ICE table. Make sure you use the correct K_a value for your weak acid and remember only molar concentration should be used in an ICE table.

Note: Use the quadratic formula.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

If HA represents your acid and A^- its conjugate base, rank the following concentrations in your initial solution: OH^-, HA, and A^-.

_______________ > _______________ > _______________

Largest concentration Smallest concentration

*Throughout this experiment, calculated and measured values should be close to each other, but they will probably not be identical. There are other factors, like the calibration of the pH meter, minor components dissolved in the water, etc., that may lead to some variation. There may also be differences in the values calculated here and those in the data analysis in LabRight.

How does your measured pH compare to the calculated value for your initial weak acid solution?*

State whether each of the following would increase, decrease, or leave the initial pH unchanged and explain your reasoning:

a. Using the same weak acid, but having a higher concentration.

b. Using 80.00 mL of this weak acid instead of 40.00 mL.

c. Using a different weak acid that has a larger K_a value.

*Just like in Experiment SST, calculated and measured values should be close to each other, but they will probably not be identical.

REGION 2: ANALYSIS BEFORE THE EQUIVALENCE POINT

Prior to the equivalence point, as base is added, the acid is being neutralized and its conjugate base is being formed: HA (aq) + OH^- (aq) → A^- (aq) + H_2O (l)

Thus, the solution contains a mixture of HA and A^-. Calculating the pH in the region involves two steps. First, we consider the neutralization reaction between HA and OH^- to determine [HA] and [A^-]. Next, we calculate the pH of this **buffer pair.**

When is it appropriate to use the Henderson-Hasselbalch approximation vs. an ICE table? If x is less than 5% of the initial concentration of HA, the Henderson-Hasselbalch approximation can be used. If this is not the case, you must use an ICE table and the quadratic formula.

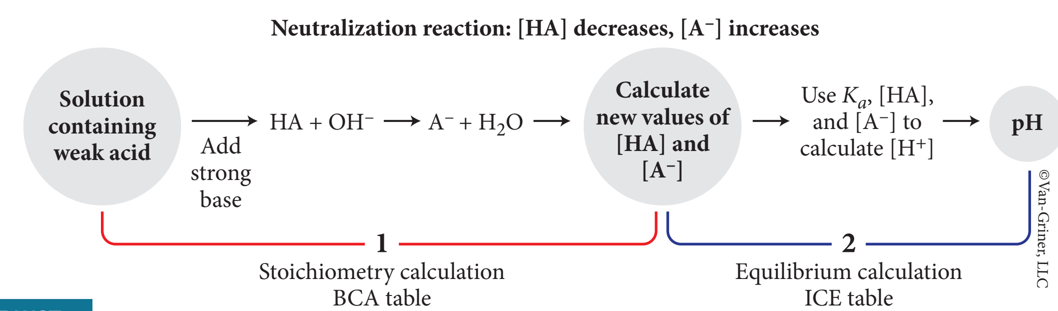

FIGURE WST.2

Calculating pH at equilibrium for a buffer pair. First, a BCA table is used to calculate the concentration of HA and A^-. Then an ICE table is used to determine the H^+ concentration. The H^+ concentration is then used to calculate the pH.

Examine the data you have collected and select a volume of base added (not buret reading) when the titration is **about 3 mL** before the ***estimated*** equivalence point. Complete the following statements using your chosen volume.

This titration involved the weak acid ____________ with a K_a *value of ____________ and the strong base NaOH. The concentration of the base was ____________ M. Initially ____________ mL of a ____________ M solution of the weak acid was added to a beaker. By adding ____________ mL (use your chosen volume of NaOH here—approximately 3 mL before equivalence point) of the base, ____________ moles of* OH^- *were added to the beaker. Based on the* ***reaction stoichiometry,*** *at this point, the concentration of [HA] = ____________ and the concentration of* $[A^-]$ *= ____________.*

(Use a table to organize your work. Remember, BCA tables help with stoichiometry, and ICE tables are applicable when calculating equilibrium.) **Show your work.**

Next, the buffer pair calculation may be accomplished by using the K_a expression or by using the Henderson-Hasselbalch approximation.

This solution has a concentration of [HA] = ____________ and $[A^-]$ = ____________ (use your values from the previous calculation). This is a **buffer** since it contains a weak acid–base conjugate pair. **Show your work.**

Determine the percent error if the change of x is ignored. Can the Henderson-Hasselbalch approximation be used?

Calculate the pH of this using the expression $K_a = \frac{[H^+][A^-]}{[HA]}$. **Do not** ignore x.

Calculate the pH using the Henderson-Hasselbalch approximation: $pH = pK_a + \log\frac{[Base]}{[Acid]}$

How does your measured pH compare to the calculated values?

REGION 3: ANALYSIS AT THE EQUIVALENCE POINT

Examine your data and select the two data points before and after the large pH jump that indicates the equivalence point. Average the "volume of base added" for these two data points and consider this your **approximate equivalence point.** Fill in the blanks by choosing option A, B, or C below.

For this titration of a weak acid and a strong base, at the equivalence point, the solution is ____________ with a pH ____________ 7. This means that, at the equivalence point, there must have been ____________ in the solution.

- **a.** Basic greater than, a base
- **b.** Neutral equal to, a neutral salt
- **c.** Acidic, less than, an acid

As base is added to the weak acid, HA, it is continually converted to A^-. At the equivalence point, all of the HA was converted to A^-. This is **not** a buffer since you no longer have the acid–base conjugate pair. Instead, you only have A^-.

If HA is a weak acid with a K_a value, then A^- must be a weak base with a K_b. It is possible to calculate the K_b by using K_a and K_w, where K_w is 1.0×10^{-14} (see Section 16.8 of your textbook).

Calculate K_b for your conjugate base.

Calculate the molarity of the conjugate base solution. Remember, all of the original acid was converted to the conjugate base. Also, account for the new total volume. (Use a table to organize your work. Remember, BCA tables help with stoichiometry, and ICE tables are applicable when calculating equilibrium.) **Show your work.**

Complete this equation describing the reaction of the conjugate base with water.

$$A^{-}\,(aq) + H_2O\,(l) \rightleftharpoons \underline{\hspace{3cm}} + \underline{\hspace{3cm}}$$

Use the K_b and calculate the pOH of the solution. **Hint: Use an ICE table and solve for OH^-. Show your work.**

Convert from pOH to pH. How does your measured pH compare to the calculated value?

REGION 4: ANALYSIS BEYOND THE EQUIVALENCE POINT

Examine your data and select a volume of base added when the titration is **about 3 mL** beyond the equivalence point. Complete the following statements using calculated values for moles, pOH, and pH:

In this titration of a weak acid with a strong base, ____________ mL of ____________ M acid was neutralized by adding ____________ M NaOH. When a total of ____________ mL of NaOH was added (use your chosen volume here—approximately 3 mL after equivalence point), ____________ moles of OH^- had been added, which completely reacted with the initial ____________ moles of H^+. After this neutralization reaction, ____________ moles of OH^- remained in the total volume of ____________ mL. This resulted in a pOH = ____________, so the pH = ____________.

(Use a table to organize your work. Remember, BCA tables help with stoichiometry, and ICE tables are applicable when calculating equilibrium.) **Show your work.**

How does your measured pH compare to the calculated value?